Endangered Species Act – Section 7 Consultation
Biological Opinion

Hogback Fish Barrier on the San Juan River

Agency:	U.S. Bureau of Reclamation
Consultation Conducted By:	U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office
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Introduction

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) based on our review of the proposed Hogback Fish Barrier Project located in San Juan County, New Mexico, and its effects on the Colorado pikeminnow (*Ptychocheilus lucius*) and its designated critical habitat and razorback sucker (*Xyrauchen texanus*) and its designated critical habitat in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402.

This BO is based on information provided in the biological assessment (BA); electronic mail and telephone conversations between our staffs; data in our files; literature review; and other sources of information.

A complete record for this consultation is on file at the New Mexico Ecological Services Field Office, Albuquerque, New Mexico.

Background and Consultation History

The Bureau of Reclamation (Reclamation), Bureau of Indian Affairs (BIA), and Service, as Federal partners of the San Juan River Basin Recovery Implementation Program (Program), are proposing to construct a fish barrier in the Hogback Irrigation Canal intake structure to minimize entrainment of fishes in the Hogback Canal.

The Program previously identified the Hogback Diversion Dam as an impediment to endangered fish migration and the diversion canal as a source of entrainment for endangered fish larvae, eggs, and juveniles. In 2002, the Program, in cooperation with the BIA and the Navajo Nation, constructed a non-selective fish passage around the Hogback Diversion Dam and installed a trash rack to minimize fish entrainment. The trash rack was not effective in preventing fish eggs, larvae, and small individuals from being entrained in the Hogback Irrigation Canal.

In 2007, Reclamation conducted a Value Engineering Study for the Hogback Diversion Dam Fish Screen Project to explore options for reducing entrainment of endangered fishes in the canal. The results of the study with options were presented to the Program's Biology Committee for consideration. On March 29, 2007, the Program Coordinator sent a letter to Reclamation supporting construction of a weir wall in the canal to prevent fish entrainment.

On April 6, 2009, Reclamation submitted a draft BA of the Hogback Fish Barrier Project to the Service for review and comment. On July 2, 2009, Reclamation submitted a revised final BA of the Hogback Fish Weir project to the Service.

Project planning was delayed until March 9, 2010, when the Service and Reclamation had a conference call to discuss how to proceed with implementation of the Hogback Fish Barrier Project. It was determined that the fish barrier is a separate project from others including reconstruction of the Hogback distribution system and that the consultation would be on only the construction and operation of the fish barrier. In addition, implementation of the Program serves as the reasonable and prudent measure for offsetting impacts from water depletions associated with the Hogback Irrigation Project.

On June 9, 2010, the Service submitted several clarifying questions to Reclamation on the July 2009 BA. Reclamation provided responses to the Service's questions on June 25, 2010.

On July 12, 2010, the Service received a letter requesting formal consultation along with a BA for the Hogback Fish Barrier on the San Juan River. The Biological Assessment included a "may affect, likely to adversely affect" determination for Colorado pikeminnow and razorback sucker and is not likely to adversely modify or destroy critical habitat for Colorado pikeminnow or razorback sucker. A July 19, 2010 letter from the Service acknowledged receipt of the request and informed Reclamation that all information needed to proceed with the consultation had been received.

Description of the Proposed Action

Action Area

The proposed action area includes the San Juan River from Navajo Dam downstream to its confluence with Lake Powell (river mile [RM] 225 to 0). The proposed construction activities would occur near the mouth of the Hogback Canal, about 0.5 miles downstream of the diversion dam and at the existing diversion dam and headworks structure. The Hogback Canal provides irrigation water from the San Juan River to Navajo Nation communities on both sides of the San Juan River from about 9 miles east of Shiprock, New Mexico to about 17 miles northwest of Shiprock near the Four Corners in San Juan County, New Mexico. The diversion dam for Hogback Canal is located on the San Juan River at RM 158, approximately 9 miles east of Shiprock.

Proposed Action

The proposed action is the construction and operation of a weir wall within Hogback Canal. The proposed project intends to reduce the potential entrainment of Colorado pikeminnow and razorback sucker as a result of the continued operation of the Hogback Irrigation Project. The proposed action includes the construction of a 330 foot concrete weir wall within the Hogback Canal approximately 0.5 miles downstream of the existing diversion dam. The diversion dam diverts a total of 200 cubic feet per second (cfs) of flow from the San Juan River. This level of diverted flow will create head causing only the top 5% of the water column to pass over the weir wall. The weir wall would maintain the flow of irrigation water to the Hogback Canal and control flows returning to the San Juan River via the existing sluice channel. The weir wall will guide fish and sediment that enter the canal back to the San Juan River via the sluice channel while allowing water at the surface that passes over the wall to enter the irrigation canal. The sluice channel will be armored to reduce erosion and protect the structure. The shallow space above the weir wall will prevent adult and juvenile fish from entering the Hogback Canal. The weir wall design is an experimental approach that is intended to prevent the entrainment of Colorado pikeminnow or razorback sucker in the Hogback Canal will also reducing the risk of impingement of endangered fish against the structure. The weir wall design is also intended to be as maintenance free as possible to reduce cost of operating the structure.

Additional modifications of the existing structures include removing approximately 50 bars on the trash rack to increase spacing from 1.5 inches to 12 inches to reduce restriction of the diversion flows.

The headwork gates will be modified so the gates can be raised by electric actuators or a portable electric drill. Access to the headgate area will also be improved and electrical power will be installed from an existing power line.

Through the Program, a remotely operated PIT tag reader system will be installed during construction of the fish weir in order to monitor endangered fish use of the Hogback Irrigation Canal and potential entrainment within the canal. The PIT tag reader will be installed to document Colorado pikeminnow or razorback sucker passing over the weir wall although the weir wall should guide these fish back to the San Juan River. The Service, through the Program will be responsible for the operation, maintenance, and data collection of the remote PIT tag reader for the Program.

Status of the Species and Critical Habitat

Colorado Pikeminnow

The Colorado pikeminnow is the largest cyprinid (member of the minnow family, Cyprinidae) native to North America and it evolved as the top predator in the Colorado River system. It is an elongated pike-like fish that once grew as large as 1.8 meters (m) (6 feet [ft]) in length and weighed nearly 45 kilograms (kg) (100 pounds [lbs]) (Behnke and Benson 1983); such fish were estimated to be 45-55 years old (Osmundson et al. 1997). Today, fish rarely exceed 1 m (approximately 3 ft) in length or weigh more than 8 kg (18 lbs). The mouth of this species is large and nearly horizontal with long slender pharyngeal teeth (located in the throat), adapted for grasping and holding prey. The diet of Colorado pikeminnow longer than 80 to 100 millimeters (mm) (3 or 4 inches [in]) consists almost entirely of other fishes (Vanicek and Kramer 1969). Adults are strongly counter-shaded with a dark, olive back, and a white belly. Young are silvery and usually have a dark, wedge-shaped spot at the base of the caudal fin.

Based on early fish collection records, archaeological finds, and other observations, the Colorado pikeminnow was once found throughout warm water reaches of the entire Colorado River Basin down to the Gulf of California, including reaches of the upper Colorado River and its major tributaries, the Green River and its major tributaries, the San Juan River and some of its tributaries, and the Gila River system in Arizona (Seethaler 1978, Platania 1990). Colorado pikeminnow apparently were never found in colder, headwater areas. Seethaler (1978) indicates that the species was abundant in suitable habitat throughout the entire Colorado River Basin prior to the 1850s. By the 1970s they were extirpated from the entire lower Basin (downstream of Glen Canyon Dam) and from portions of the upper Basin as a result of major alterations to the riverine environment. Having lost approximately 75-80% of its former range, the Colorado pikeminnow was federally listed as an endangered species in 1967 (Miller 1961, Moyle 1976, Tyus 1991, Osmundson and Burnham 1998).

Critical habitat is defined as the areas that provide physical or biological features that are essential for the conservation of the species. Critical habitat was designated for the Colorado pikeminnow in 1994, within the 100-year floodplain of the species' historical range in the following section of the San Juan River Basin (Maddux et al. 1993, Service 1994), the San Juan River from the State Route 371 Bridge in Section 17, T 29N, R13W, San Juan County, New Mexico to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell in Section 26, T41S, R11E, , San Juan County, Utah.

The Service identified water, physical habitat, and the biological environment as primary constituent elements of critical habitat. This includes a quantity of water of sufficient quality that is delivered to specific habitats in accordance with a hydrologic regime that is required for the particular life stage for the species. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide access to spawning, nursery, feeding, and rearing habitats, are included. Food supply, predation, and competition are important elements of the biological environment.

Life History

The life history phases that appear to be most limiting for Colorado pikeminnow populations include spawning, egg hatching, development of larvae, and the first year of life. These phases of Colorado pikeminnow development are tied closely to specific habitat requirements. Natural spawning of Colorado pikeminnow is initiated on the descending limb of the annual hydrograph as water temperatures approach the range of 16˚C (60.8˚F) to 20˚C (68˚F) (Vanicek and Kramer 1969, Hamman 1981, Haynes et al. 1984, Tyus 1990, McAda and Kaeding 1991). Temperature at initiation of spawning varies by river. In the Green River, spawning begins as temperatures exceed 20-23˚C (68-73˚F); in the Yampa River, 16-23˚C (61-68˚F) (Bestgen et al. 1998); in the Colorado River, 18-22˚C (64-72˚F) (McAda and Kaeding 1991); in the San Juan River temperatures were estimated to be 16-22˚C (61-72˚F). Spawning, both in the hatchery and under natural riverine conditions, generally occurs in a 2-month period between late June and late August. However, sustained high flows during wet years may suppress river temperatures and extend spawning into September (McAda and Kaeding 1991). Conversely, during low flow years, when the water warms earlier, spawning may commence in mid-June. On the San Juan River, based on the collection of larval fish from 1993 to 2007, spawning occurred between June 24 and July 18 (Brandenburg and Farrington 2008).

Temperature also has an effect on egg development and hatching success. In the laboratory, egg development was tested at five temperatures and hatching success was found to be highest at 20˚C (68˚F), and lower at 25˚C (77˚F). Mortality was 100 percent at 5, 10, 15, and 30˚C (41, 50, 59, and 86˚F). In addition, larval abnormalities were twice as high at 25˚C (77˚F) than at 20˚C (68˚F) (Marsh 1985). Experimental tests of temperature preference of yearling (Black and Bulkley 1985) and adult (Bulkley et al. 1981) Colorado pikeminnow indicated that 25˚C (77˚F) was the most preferred temperature for both life phases. Additional experiments indicated that optimum growth of yearlings also occurs at temperatures near 25˚C (77˚F) (Black and Bulkley 1985). Although no such tests were conducted using adults, the tests with yearlings supported the conclusions of Jobling (1981) that the final thermal preference of 25˚C (77˚F) provides a good indication of optimum growth temperature for all life phases.

Males become sexually mature earlier and at a smaller size than do females, though all are mature by about age 7 and 500 mm (20 in) in length (Vanicek and Kramer 1969, Seethaler 1978, Hamman 1981). Hatchery-reared males became sexually mature at 4 years of age and females at 5 years. Average fecundity of 24, 9-year old females was 77,400 (range, 57,766–113,341) or 55,533 eggs/kg, and average fecundity of 9 ten-year old females was 66,185 (range, 11,977–91,040) or 45,451 eggs/kg (Hamman 1986).

Most information on Colorado pikeminnow reproduction has been gathered from spawning sites on the lower 20 miles (12.2 kilometers) of the Yampa River and in Gray Canyon on the Green River (Tyus and McAda 1984, Tyus 1985, Wick et al. 1985, Tyus 1990). Colorado pikeminnow spawn after peak runoff subsides. Spawning is probably triggered by several interacting variables such as day length, temperature, flow level, and perhaps substrate characteristics (USFWS 2002a). Known spawning sites in the Yampa River are characterized by riffles or shallow runs with well-washed coarse substrate (cobble containing relatively deep interstitial voids (for egg deposition) in association with deep pools or areas of slow non-turbulent flow used as staging areas by adults (Lamarra et al. 1985, Tyus 1990). Investigations at a spawning site in the San Juan River by Bliesner and Lamarra (1995) and at one site in the upper Colorado River (Service unpubl. data) indicate a similar association of habitats. The most unique feature at the sites used for spawning, in comparison with otherwise similar sites nearby, is the lack of embeddedness of the cobble substrate and the depth to which the rocks are devoid of fine sediments; this appears consistent at the sites in all three rivers (Lamarra et al. 1985, Bliesner and Lamarra 1995).

Collections of larvae and young-of-year (YOY) Colorado pikeminnow downstream of known spawning sites in the Green, Yampa, and San Juan Rivers demonstrate that downstream drift of larval Colorado pikeminnow occurs following hatching (Haynes et al. 1984, Nesler et al. 1988, Tyus 1990, Tyus and Haines 1991, Platania 1990, Ryden 2003). Studies on the Green and Colorado Rivers found that YOY used backwaters almost exclusively (Holden 2000). During their first year of life, Colorado pikeminnow prefer warm, turbid, relatively deep (averaging 0.4 m [1.3 ft]) backwater areas of zero velocity (Tyus and Haines 1991). After about 1 year, young are rarely found in such habitats, although juveniles and subadults are often located in large deep backwaters during spring runoff (Service, unpublished data; Osmundson and Burnham 1998).

Colorado pikeminnow often migrate considerable distances to spawn in the Green and Yampa Rivers (Miller et al. 1982, Tyus and McAda 1984, Tyus 1985, Archer et al. 1986, Tyus 1990), and similar movement has been noted in the main stem San Juan River. A fish captured and tagged in the San Juan arm of Lake Powell in April 1987, was recaptured in the San Juan River approximately 80 miles upstream in September 1987 (Platania 1990). Ryden and Ahlm (1996) report that a Colorado pikeminnow captured at river mile (RM) 74.8 (between Bluff and Mexican Hat) made a 50-60 mile migration during the spawning season in 1994, before returning to within 0.4 river miles of its original capture location.

Although migratory behavior has been documented for Colorado pikeminnow in the San Juan River (Platania 1990, Ryden and Ahlm 1996), of 13 radio-tagged fish tracked from 1991 to 1994, 12 were classified as sedentary and only one as migratory (Ryden and Ahlm 1996). Miller and Ptacek (2000) followed 7 radio-tagged wild Colorado pikeminnow in the San Juan River and found these fish to also use a localized area of the river (RM 120 to RM 142). In contrast to Colorado pikeminnow in the Green and Yampa rivers, the majority of Colorado pikeminnow in the San Juan River reside near the area in which they spawn (Ryden and Ahlm 1996, Miller and Ptacek 2000). During their study, Ryden and Ahlm (1996) found that Colorado pikeminnow in the San Juan River aggregated at the mouth of the Mancos River prior to spawning, a behavior not documented in other rivers in the upper Colorado River Basin. Miller and Ptacek (2000) also recorded two Colorado pikeminnow in both 1993 and 1994 at the mouth of the Mancos River prior to the spawning period.

Historical spawning areas for the Colorado pikeminnow in the San Juan River are unknown; however, Platania (1990) speculated that spawning likely occurred upstream at least to Rosa, New Mexico. Two locations in the San Juan River have been identified as potential spawning areas based on radio telemetry and visual observations (Ryden and Pfeifer 1994, Miller and Ptacek 2000). Both locations occur within the "Mixer" (RM 133.4 to 129.8), a geomorphically distinct reach of the San Juan River. The upper spawning location is located at RM 132 and the lower spawning location at approximately RM 131.1. Both locations consist of complex habitat associated with cobble bar and island complexes. Habitat at these locations is similar to spawning habitats described for the Yampa River and is composed of side channels, chutes, riffles, slow runs, backwaters, and slackwater areas near bars and islands. Substrate in the riffle areas is clean cobbles, primarily 7.6 to 10.2 centimeters (3 to 4 in) in diameter (Miller and Ptacek 2000). Habitat characteristics at the lower spawning area, based on radio telemetry and visual observations, include a fast narrow chute adjacent to a small eddy.

During 1993, radio-tagged Colorado pikeminnow were observed moving to potential spawning locations in the Mixer beginning around July 1. Fish were in the spawning areas from approximately July 12 to July 25. During this period flows in the San Juan River were on the descending limb of the spring runoff. Temperatures increased from approximately 20 to 25˚C (68 to 77˚F) during the same time period. Observations in other years show a similar pattern. However, specific spawning times and duration of the spawning period appear to vary from year to year. Information on radio-tagged adult Colorado pikeminnow during the fall suggests that Colorado pikeminnow seek out deep water areas in the Colorado River (Miller et al. 1982, Osmundson and Kaeding 1989), as do many other riverine species. Pools, runs, and other deep water areas, especially in upstream reaches, are important winter habitats for Colorado pikeminnow (Osmundson et al. 1995).

On the Green River, tributaries are an important habitat component for Colorado pikeminnow (Holden 2000). Both the Yampa River and White River were heavily used by Colorado pikeminnow subadults and adults, apparently as foraging areas (Tyus 1991). The tributaries were the primary area of residence to which the adults returned after spawning. Tributaries to the San Juan River no longer provide habitat for adults because they are dewatered or access is restricted (Holden 2000). Colorado pikeminnow utilized the Animas River in the late 1800s. This river could still provide suitable habitat; however, the present Colorado pikeminnow population is downstream from the mouth of the Animas River about 50 miles (Holden 2000). Colorado pikeminnow aggregated at the mouth of the Mancos River prior to spawning in the early 1990s, possibly indicating the importance of this tributary for reproductive behavior (Ryden and Ahlm 1996, Miller and Ptacek 2000).

Very little information is available on the influence of turbidity on the endangered Colorado River fishes. Osmundson and Kaeding (1989) found that turbidity allows use of relatively shallow habitats ostensibly by providing adults with cover; this allows foraging and resting in areas otherwise exposed to avian or terrestrial predators. Tyus and Haines (1991) found that young Colorado pikeminnow in the Green River preferred backwaters that were turbid. Clear conditions in these shallow waters might expose young fish to predation from wading birds or exotic, sight-feeding, piscivorous fish. It is unknown whether the river was as turbid historically as it is today. For now, it is assumed that these endemic fishes evolved under conditions of high turbidity (USFWS 2009). Therefore, the retention of these highly turbid conditions is probably an important factor in maintaining the ability of these fish to compete with non-natives that may not have evolved under similar conditions.

Population Dynamics

Due to the low numbers of Colorado pikeminnow collected in the San Juan River, it is not possible to quantify population size or trends. Estimates during a seven-year research period between 1991 and 1997 suggested that there were fewer than 50 adults in a given year (Ryden 2000a). The ability of the Colorado pikeminnow to withstand adverse impacts to its populations and its habitat is difficult to discern given the longevity of individuals and their scarcity within the San Juan River Basin. At this stage of investigations on the San Juan River, the younger life stages are considered the most vulnerable to predation, competition, toxic chemicals, and habitat degradation (USFWS 2009). The ability of a population to rebound from these impacts may take several years or more.

Between 1991 and 1995, 19 (17 adult and 2 juvenile) wild Colorado pikeminnow were collected in the San Juan River by electrofishing (Ryden 2000a). Wild adult Colorado pikeminnow were most abundant between RM 142 (the former Cudei Diversion) and Four Corners at RM 119 (Ryden and Ahlm 1996) and they primarily used the San Juan River between these points (Ryden and Pfeifer 1993, 1994, 1995, 1996). The multi-threaded channel, habitat complexity, and mixture of substrate types in this area of the river appear to provide a diversity of habitats favorable to Colorado pikeminnow on a year-round basis (Holden and Masslich 1997).

Colorado pikeminnow reproduction was documented in the San Juan River in 1987, 1988, 1992-1996, 2001, 2004, and 2007 by the collection of larvae or YOY (Buntjer et al. 1994, Lashmett 1994, Archer et al. 1995, Platania 1990, Brandenburg and Farrington 2008). The majority of the YOY Colorado pikeminnow were collected in the San Juan River inflow to Lake Powell (Buntjer et al. 1994, Lashmett 1994, Archer et al. 1995, Platania 1990). Some YOY Colorado pikeminnow have been collected in the San Juan River near the Mancos River confluence, New Mexico, in the vicinity of the Montezuma Creek confluence near Bluff, Utah, and at a fish survey station near Mexican Hat, Utah (Buntjer et al. 1994, Snyder and Platania 1995). The collection of larval fish (only a few days old) at Mexican Hat in two different years suggests that perhaps another spawning area for Colorado pikeminnow exists somewhere below the Mixer (Platania 1996). Capture of a larval Colorado pikeminnow at RM 128 during August 1996 was the first larva collected immediately below the suspected spawning site in the Mixer (Holden and Masslich 1997). Recent studies found catch rates for YOY Colorado pikeminnow to be highest in high water years, such as 1993 (Buntjer et al. 1994, Lashmett 1994). Franssen et al. (2007) found that maintenance of a natural flow regime favored native fish reproduction and provided a prey base at the appropriate time for age-1 Colorado pikeminnow.

Competition and Predation

Colorado pikeminnow in the upper Colorado River Basin live with about 20 species of warm-water non-native fishes (Tyus et al. 1982, Lentsch et al. 1996) that are potential predators, competitors, and vectors for parasites and disease. Backwaters and other low-velocity habitats in the San Juan River are important nursery areas for larval and juvenile Colorado pikeminnow (Holden 1999) and researchers believe that non-native fish species limit the success of Colorado pikeminnow recruitment (Bestgen 1997, Bestgen et al. 1997, McAda and Ryel 1999). Osmundson (1987) documented predation by black bullhead (*Ameiurus melas*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), and black crappie (*Pomoxis nigromaculatus*) as a significant mortality factor for YOY and yearling Colorado pikeminnow stocked in riverside ponds along the upper Colorado River. Adult red shiners (*Cyprinella lutrensis*) are known predators of larval native fish in backwaters of the upper Basin (Ruppert et al. 1993). High spatial overlap in habitat use has been documented among young Colorado pikeminnow, red shiner, sand shiner (*Notropis stramineus*), and fathead minnow (*Pimephales promelas*). In laboratory experiments on behavioral interactions, Karp and Tyus (1990) observed that red shiner, fathead minnow, and green sunfish shared activity schedules and space with young Colorado pikeminnow and exhibited antagonistic behaviors to smaller Colorado pikeminnow. They hypothesized that Colorado pikeminnow may be at a competitive disadvantage in an environment that is resource limited.

Channel catfish (*Ictalurus punctatus*) has been identified as a threat to juvenile, subadult, and adult Colorado pikeminnow in the San Juan River (USFWS 2002a). Channel catfish were first introduced in the upper Colorado River Basin in 1892 (Tyus and Nikirk 1990) and are now considered common to abundant throughout much of the upper Basin (Tyus et al. 1982, Nelson et al. 1995). The species is one of the most prolific predators in the upper Basin and, among the non-native fishes, is thought to have the greatest adverse effect on endangered fishes due to predation on juveniles and resource overlap with subadults and adults (Hawkins and Nesler 1991, Lentsch et al. 1996, Tyus and Saunders 1996). Stocked juvenile and adult Colorado pikeminnow that have preyed on channel catfish have died from choking on the pectoral spines

(McAda 1983, Pimental et al. 1985). Although mechanical removal (electrofishing, seining) of channel catfish began in 1995, intensive efforts (10 trips/year) did not begin until 2001. Mechanical removal has not yet led to a positive population response in Colorado pikeminnow (Davis 2003); however, because the Colorado pikeminnow population is so low, documenting a population response would be extremely difficult.

Status and Distribution

The Colorado pikeminnow was designated as endangered prior to the Act; therefore, a formal listing package identifying threats was not prepared. Construction and operation of main stem dams, non-native fish, and local eradication of native minnow and suckers in the early 1960s were recognized as early threats (Miller 1961, Holden 1991). The Colorado pikeminnow recovery goals (Service 2002a) summarize threats to the species as follows: stream regulation, habitat modification, competition with and predation by non-native fish, and pesticides and pollutants.

Major declines in Colorado pikeminnow populations occurred in the lower Colorado River Basin during the dam-building era of the 1930s through the 1960s (USFWS 2002a). Behnke and Benson (1983) summarized the decline of the natural ecosystem, pointing out that dams, impoundments, and water use practices drastically modified the river's natural hydrology and channel characteristics throughout the Colorado River Basin. Dams on the main stem fragmented the river ecosystem into a series of disjunct segments, blocked native fish migrations, reduced water temperatures downstream of dams, created lake habitat, and provided conditions that allow competitive and predatory non-native fishes to thrive both within the impounded reservoirs and in the modified river segments that connect them (USFWS 2009). The highly modified flow regime in the lower Basin coupled with the introduction of non-native fishes decimated populations of native fish (USFWS 2002a).

In the upper Colorado River Basin, declines in Colorado pikeminnow populations occurred primarily after the 1960s, when the following dams were constructed: Glen Canyon Dam on the main stem Colorado River, Flaming Gorge Dam on the Green River, Navajo Dam on the San Juan River, and the Aspinall Unit dams on the Gunnison River. Some native fish populations in the upper Basin have managed to persist, while others are nearly extirpated. River reaches where native fish have declined more slowly tend to have pre-dam hydrologic regimes where adequate habitat for all life phases still exists and migration corridors that allow connectivity among habitats used during the various life phases.

Razorback Sucker

Like all suckers (family Catastomidae, meaning "down mouth"), the razorback sucker has a ventral mouth with thick lips covered with papillae and no scales on its head. In general, suckers are bottom browsers, sucking up or scraping off small invertebrates, algae, and organic matter with their fleshy, protrusible lips (Moyle 1976). The razorback sucker is the only sucker with an abrupt sharp-edged dorsal keel behind its head. The keel becomes more massive with age. The head and keel are dark, the back is olive-colored, the sides are brownish or reddish, and the abdomen is yellowish white (Sublette et al. 1990). Adults often exceed 3 kg (6 lbs) in weight and 600 mm (2 ft) in length. Like Colorado pikeminnow, razorback suckers may live 40-plus years.

Historically, razorback suckers were found in the main stem Colorado River and major tributaries in Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming, and Mexico (Minckley 1983). Bestgen (1990) reported that this species was once so numerous that it was commonly used as food by early settlers and that a commercially marketable quantity was caught in Arizona as recently as 1949. In the upper Colorado River Basin, razorback suckers were reported to be very abundant in the Green River near Green River, Utah, in the late 1800s (Jordan 1891). An account in Osmundson and Kaeding (1989) reported that residents living along the Colorado River near Clifton, Colorado, observed several thousand razorback suckers during spring runoff in the 1930s and early 1940s. In the San Juan River drainage, the first razorback sucker was documented in 1988 (Platania 1990); however, two adults were also collected from an irrigation pond attached to the river by a canal in 1976 (Platania 1990) and it is very likely that razorback sucker once occurred in the main stem as far upstream as Rosa, New Mexico (Ryden 1997).

The marked decline in populations of razorback suckers can be attributed to construction of dams and reservoirs, introduction of non-native fishes, and removal of large quantities of water from the Colorado River system (USFWS 2002b). Dams on the main stem Colorado River and its major tributaries have fragmented populations and blocked migration routes. Dams also have drastically altered flows, water temperatures, and channel geomorphology. These changes have modified habitats in many areas so that they are no longer suitable for breeding, feeding, or sheltering. Major changes in species composition have occurred due to the introduction of non-native fishes, many of which have thrived due to man-induced changes to the natural riverine system. Habitat has been significantly degraded to a point where it impairs the essential life history functions of razorback sucker, such as reproduction and recruitment into the adult population (USFWS 2009).

On March 14, 1989, the Service was petitioned to conduct a status review of the razorback sucker. Subsequently, the razorback sucker was designated as endangered on October 23, 1991 (Service 1991). The final rule stated that “Little evidence of natural recruitment has been found in the past 30 years, and numbers of adult fish captured in the last 10 years demonstrate a downward trend relative to historic abundance. Significant changes have occurred in razorback sucker habitat through diversion and depletion of water, introduction of nonnative fishes, and construction and operation of dams" (Service 1994). Recruitment of larval razorback suckers to juveniles and adults continues to be a problem.

Critical habitat was designated in 1994, within the 100-year flood plain of the razorback sucker's historical range in the following area of the upper Colorado River (Service 1994), the San Juan River from the Hogback Diversion in Section 9, T29N, R16W, San Juan County, New Mexico, to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell in Section 26, T41S, R11E, San Juan County, Utah. The primary constituent elements of critical habitat are the same as those described earlier for Colorado pikeminnow.

Life History

McAda and Wydoski (1980) and Tyus (1987) reported springtime aggregations of razorback suckers in off-channel habitats and tributaries; such aggregations are believed to be associated with reproductive activities. Tyus and Karp (1990) and Osmundson and Kaeding (1991) reported off-channel habitats to be much warmer than the main stem river and that razorback suckers presumably moved to these areas for feeding, resting, sexual maturation, spawning, and other activities associated with their reproductive cycle.

While razorback suckers have never been directly observed spawning in turbid riverine environments within the upper Colorado River Basin, captures of ripe specimens, both males and females, have been recorded in the Yampa, Green, Colorado, and San Juan Rivers (McAda and Wydoski 1980, Valdez et al. 1982, Tyus 1987, Osmundson and Kaeding 1989, Tyus and Karp 1989, Platania 1990, Tyus and Karp 1990, Osmundson and Kaeding 1991, Ryden 2000b). Because of the relatively steep gradient in the San Juan River and lack of a wide flood plain, razorback sucker are likely spawning in low velocity, turbid, main channel habitats. Aggregations of ripe adults have been documented and based on catches of protolarvae, it appears that there are most likely three spawning locations in the San Juan River (Brandenburg and Farrington 2008).

Sexually mature razorback suckers are generally collected on the ascending limb of the hydrograph from mid-April through June and are associated with coarse gravel substrates. Both sexes mature as early as age four (McAda and Wydoski 1980). Fecundity, based on ovarian egg counts, ranges from 75,000-144,000 eggs (Minckley 1983). McAda and Wydoski (1980) reported an average fecundity (N=10) of 46,740 eggs/fish. Several males attend each female; no nest is built. The adhesive eggs drift to the bottom and hatch there (Sublette et al. 1990). Marsh (1985) reported that percentage egg hatch was greatest at 20˚C (68˚F) and all embryos died at incubation temperatures of 5, 10, and 30˚C (41, 50, and 86˚F).

Because young and juvenile razorback suckers are rarely encountered, their habitat requirements are not well known, particularly in native riverine environments. However, it is assumed that low-velocity backwaters and side channels are important for YOY and juveniles, as it is to the early life stages of most riverine fish. Prior to construction of large main stem dams and the suppression of spring peak flows, low velocity, off-channel habitats (seasonally flooded bottomlands and shorelines) were commonly available throughout the upper Colorado River Basin (Tyus and Karp 1989, Osmundson and Kaeding 1991). Modde (1996) found that on the Green River, larval razorback suckers entered flooded bottomlands that were connected to the main channel during high flow. However, because of the relatively steep gradient of the San Juan River and the lack of a wide flood plain, flooded bottomlands are probably much less important in this system than are other low velocity habitats such as backwaters and secondary channels (Ryden 2004).

Reduction in spring peak flows eliminates or reduces the frequency of inundation of off-channel and bottomland habitats. The absence of these seasonally flooded riverine habitats is believed to be a limiting factor in the successful recruitment of razorback suckers in other upper Colorado River streams (Tyus and Karp 1989, Osmundson and Kaeding 1991). Wydoski and Wick (1998) identified starvation of larval razorback suckers due to low zooplankton densities in the main channel and loss of floodplain habitats that provide adequate zooplankton densities for larval food as one of the most important factors limiting recruitment.

Outside of the spawning season, adult razorback suckers occupy a variety of shoreline and main channel habitats including slow runs, shallow to deep pools, backwaters, eddies, and other relatively slow velocity areas associated with sand substrates (Tyus 1987, Tyus and Karp 1989, Osmundson and Kaeding 1989, Valdez and Masslich 1989, Tyus and Karp 1990, Osmundson and Kaeding 1991). Their diet consists primarily of algae, plant debris, and aquatic insect larvae (Sublette et al. 1990). McAda and Wydowski (1980) and Bestgen (1990) suggest that the diet of razorback sucker was composed primarily of "ooze," (i.e., plant detritus with associated bacteria, fungus and zooplankton) as well as insect larvae. Papoulias and Minckley (1992) found that razorback sucker larvae exhibited prey-size selection, based on body width. Marsh and Langhorst (1988) examined the stomachs of 34 adult specimens from Lake Mohave and found contents dominated by planktonic crustaceans, diatoms, filamentous algae, and detritus. Jonez and Sumner (1954) reported midge larvae as the dominant food item in their stomach analysis of razorback suckers in Lake Mohave. They also reported algae as the most common food item found in razorback sucker stomachs from Lake Mead, followed by plankton, insects, and decaying organic matter. Vanicek (1967) examined eight adult razorback sucker stomachs from the Green River and found them packed with mud or clay containing chironomid larvae, plant stems, and leaves.

Population Dynamics

Because wild razorback sucker are rarely encountered and they are a long-lived fish, it is difficult to determine natural fluctuations in the population. The existing scientific literature and historic accounts by local residents strongly suggest that razorback suckers were once a viable, reproducing member of the native fish community in the San Juan River drainage. Currently, razorback sucker is rare throughout its historic range and extremely rare in the main stem San Juan River. Until 2003, there was very limited evidence indicating natural recruitment to any population of razorback sucker in the Colorado River system (Tyus 1987, McCarthy and Minckley 1987, Osmundson and Kaeding 1989, Bestgen 1990, Platania 1990, Platania et al. 1991, Modde et al. 1996). In 2003, two juvenile (age-2) razorback sucker, 249 and 270 mm (9.8 and 10.6 in), thought to be wild-produced from stocked fish were collected in the lower San Juan River (RM 35.7 and 4.8) (Ryden 2004). One age-1 razorback sucker, also thought to be wild-produced, was caught each in 2004 and 2006 (Brandenburg and Farrington 2007) indicating limited recruitment may be occurring.

Competition and Predation

Many species of non-native fishes occur in occupied habitat of the razorback sucker. These non-native fishes are predators, competitors, and vectors of parasites and diseases (Tyus et al. 1982, Lentsch et al. 1996, Pacey and Marsh 1999, Marsh et al. 2001). Many researchers believe that non-native species are a major cause for the lack of recruitment (McAda and Wydoski 1980, Minckley 1983, Tyus 1987, Muth et al. 2000). There are reports of predation of razorback sucker eggs and larvae by common carp (*Cyprinus carpio*), channel catfish, smallmouth bass (*Micropterus dolomeiui*), largemouth bass, bluegill (*Lepomis macrochirus*), green sunfish, and redear sunfish (*Lepomis microlophus*) (Jonez and Sumner 1954, Marsh and Langshorst 1988, Langhorst 1989). Marsh and Langhorst (1988) found higher growth rates in larval razorback sucker in the absence of predators in Lake Mohave, and Marsh and Brooks (1989) reported that channel catfish and flathead catfish were major predators of stocked razorback sucker in the Gila River. Juvenile razorback sucker (average total length 171 mm [6.7 in]) stocked in isolated coves along the Colorado River in California, suffered extensive predation by channel catfish and largemouth bass (Langhorst 1989). Aggressive behavior between channel catfish and adult razorback sucker has been inferred from the presence of distinct bite marks on the dorsal keels of four razorback suckers that match the bite characteristics of channel catfish (Ryden 2004).

Carpenter and Mueller (2008) tested nine non-native species of fish that co-occur with razorback sucker and found that seven species consumed significant numbers of larval razorback suckers. The seven species consumed an average of 54 – 99 percent of the razorback sucker larvae even though alternative food was available (Carpenter and Mueller 2008). Lentsch et al. (1996) identified six species of non-native fishes in the upper Colorado River basin as threats to razorback sucker: red shiner, common carp, sand shiner, fathead minnow, channel catfish, and green sunfish. Smaller fish, such as adult red shiner, are known predators of larval native fish (Ruppert et al. 1993). Large predators, such as walleye (*Stizostedion vitreum*), northern pike (*Esox lucius*), and striped bass (*Morone saxatilis*), also pose a threat to subadult and adult razorback sucker (Tyus and Beard 1990). Pilger et al. (2008) found that although non-native fishes comprised more than 80 percent of the potential prey base in the San Juan River, significantly more native fishes (mainly sucker species) were identified in the stomachs of juvenile largemouth bass.

Status and Distribution

A marked decline in populations of razorback suckers can be attributed to construction of dams and reservoirs, introduction of non-native fishes and removal of large quantities of water from the Colorado River system (Service 1991). Dams on the mainstem Colorado River and its major tributaries have fragmented populations and blocked migration routes. Dams also have drastically altered flows, water temperatures, and channel geomorphology. These changes have modified habitats in many areas so that they are no longer suitable for breeding, feeding, or sheltering. Major changes in species composition have occurred due to the introduction of non-native fishes, many of which have thrived due to human-induced changes to the natural riverine system (USFWS 2002b). Habitat has been significantly degraded to a point where it impairs the essential life history functions of razorback sucker, such as reproduction and recruitment into the adult population (USFWS 2009).

Currently, the largest concentration of wild adult razorback sucker remaining in the Colorado River basin is in Lake Mohave (USFWS 2002b). Estimates of the wild stock in Lake Mohave have fallen precipitously in recent years from 60,000 in 1991, 25,000 in 1993 (Marsh 1993, Holden 1994), to fewer than 3,000 in 2001 (Marsh et al. 2003). A repatriation program began in Lake Mohave in 1991, and repatriated fish have apparently begun to contribute to larval cohorts (Turner et al. 2007). Until recently, efforts to introduce young razorback sucker into Lake Mohave have failed because of predation by non-native species (Minckley et al. 1991, Clarkson et al. 1993, Burke 1994, Marsh et al. 2003). Natural populations elsewhere in the Colorado River system remain non-sustaining or have been extirpated (Marsh et al. 2003).

In the upper Colorado River Basin, above Glen Canyon Dam, razorback suckers are found in limited numbers in both lentic (lake-like) and riverine environments. The largest populations of razorback suckers in the upper Basin are found in the upper Green and lower Yampa Rivers (Tyus 1987). Lanigan and Tyus (1989) estimated a population of 948 adults (95 percent confidence interval: 758 to 1,138) in the upper Green River. Eight years later, the population was estimated at 524 adults (95 percent confidence interval: 351-696) and the population was characterized as stable or declining slowly with some evidence of recruitment (Modde et al.

1996). They attributed this suspected recruitment to unusually high spring flows during 1983–1986 that inundated portions of the floodplain used as nurseries by young. In the Colorado River, most razorback suckers occur in the Grand Valley area near Grand Junction, Colorado; however, they are increasingly rare. Osmundson and Kaeding (1991) reported that the number of razorback sucker captures in the Grand Junction area has declined dramatically since 1974. Between 1984 and 1990, intensive collecting effort captured only 12 individuals in the Grand Valley (Osmundson and Kaeding 1991). The wild population of razorback sucker is considered extirpated from the Gunnison River (Burdick and Bonar 1997).

Scientifically documented records of wild razorback sucker adults in the San Juan River are limited to two fish captured in a riverside pond near Bluff, Utah in 1976, and one fish captured in the river in 1988, also near Bluff (Platania 1990). Large numbers were anecdotally reported from a drained pond near Bluff in 1976, but no specimens were preserved to verify the species. No wild razorback suckers were found during the 7-year research period (1991-1997) of the Program (Holden 1999). Hatchery-reared razorback sucker, especially fish greater than 350 mm (13.8 in) introduced into the San Juan River in the 1990s have survived and reproduced, as evidenced by recapture data and collection of larval fish (Brandenburg and Farrington 2008).

Without intervention through propagation and augmentation and non-native fish removal programs, razorback sucker would be in imminent danger of extirpation in the wild. The razorback sucker Recovery Goals identified streamflow regulation, habitat modification, predation by non-native fish species, and pesticides and pollutants as the primary threats to the species (Service 2002b). Within the upper Colorado River basin, recovery efforts include the capture and genetic analysis and development of brood stock from all known locations. In the short term, stocking may be the only means to prevent the extirpation of razorback sucker in the upper Colorado River basin. However, in the long term it is expected that natural reproduction and recruitment will occur in the recovered populations (USFWS 2009). A genetics management plan and an augmentation plan have been written for the razorback sucker (Crist and Ryden 2003).

At the time of listing, few razorback suckers remained in the San Juan River. Since the initiation of the San Juan River Basin Recovery Implementation Program (SJRRIP), razorback sucker numbers have increased, primarily due to an aggressive augmentation program. However, in the absence of management efforts to recover razorback sucker, their long-term viability remains uncertain because of the relatively limited or degraded habitat available to them between Navajo Dam and Lake Powell, competition and predation from non-native fishes, water quality issues, and the uncertainty surrounding the changes that climate change will bring to the San Juan River Basin.

Environmental Baseline

The Environmental Baseline includes the past and present impacts of all Federal, State, and private actions and other human activities in the action area; the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal section 7 consultation; and the impact of State or private actions contemporaneous with the consultation process. All projects previously built or consulted on, and those State or private projects presently being built or considered that deplete water from the San Juan River Basin are in the Environmental Baseline for this proposed action. The baseline does not include the effects of the action under review, only actions that have occurred previously.

The Service describes the environmental baseline in terms of the biological requirements for habitat features and processes necessary to support life stages of the subject species within the action area. When the environmental baseline departs from those biological requirements, the adverse effects of a proposed action on the species or proposed critical habitat are more likely to jeopardize the listed species or result in destruction or adverse modification of proposed critical habitat.

Status of the Species within the Action Area

Colorado pikeminnow

Platania and Young (1989) summarized historic fish collections in the San Juan River drainage that indicate that Colorado pikeminnow once inhabited reaches above what is now the Navajo Dam and Reservoir near Rosa, New Mexico. Lake Powell and Navajo Reservoir resulted in the direct loss of approximately 161 km (100 mi) of San Juan River habitat for the two endangered fishes (Holden 2000). Since closure of Navajo Dam in 1963, the accompanying fish eradication program, physical changes associated with the dam, and barriers to movement, wild Colorado pikeminnow have been eliminated from the upper San Juan River upstream of Navajo Dam. Below Navajo Dam, summer water temperatures are colder and winter water temperatures are warmer than the pre-dam condition. The 10 km (6.2 mi) below the dam are essentially sediment free, resulting in the clearest water of any reach (Miller and Ptacek 2000). The cool, clear water has allowed development of an intensively managed blue-ribbon trout fishery to the exclusion of the native species (Miller and Ptacek 2000).

Mark-recapture estimates from 1991-1997 adult monitoring determined that there were 19 wild adult Colorado pikeminnow in the San Juan River from RM 136.6 to RM 119.2 (95% C.I. 10-42; Ryden 2000a). Radio-tagged adults appear to have relatively small home ranges and primarily use habitats from RM 109 to RM 142. The exception to this trend was one fish with a large home range that consistently used habitats immediately downstream of Bluff, UT (RM 80;

Ryden 2000a). Spawning has been documented in a region of high channel complexity characterized by shifting gravel bars from RM 133.4 to RM 129.8 (Ryden 2000a). Additional suitable spawning habitat has been identified at RM 178.7 and 168.4 (Bliesner and Lamarra 2003). Drift data from 1995 suggested a spawning site considerably downstream of RM 129 (Platania et al. 2000) but its location was not identified. Prior to spawning, adults stage at the mouth of the Mancos River. Spawning dates (back calculated from larval drift) range from July 8 to August 12 (Platania et al. 2000). Larval and juvenile Colorado pikeminnow have been collected from low velocity shoreline and pocketwater habitats downstream of RM 130 (Ryden 2000a).

Between 1987 and 1996, no wild Colorado pikeminnow adults were caught above Shiprock (approximately RM 150). Radio telemetry studies conducted from 1991 to 1995 indicated that Colorado pikeminnow remained within a relatively small area of the river, between RM 110 to RM 142 (Holden 2000). The removal of the diversion at Cudei (RM 142), construction of non-selective fish passage at the Hogback diversion (RM 158.6) and the completion of the PNM (RM 166.1) selective fish passage ladder in 2003, has restored fish access to about 36 miles of critical habitat on the San Juan River for Colorado pikeminnow. In 2004 five Colorado pikeminnow (226-250 mm total length [8.9-9.8 in]) were caught in the lower few miles of the Animas River (Ryden and McAda 2005). These fish were all age-2 that had been stocked in June 2004 about 0.3 RMs downstream of the Animas River confluence (Ryden and McAda 2005). During the seven-year research period (1991 to 1997) it was estimated that there were fewer than 50 adults in the San Juan River in any given year (Ryden 2000a).

Experimental stocking of Colorado pikeminnow in the San Juan River began in 1996. Between 1996 and 2000, approximately 832,000 larval Colorado pikeminnow were stocked in the San Juan River. About 727,000 were stocked between RM 141 and 158. The balance was stocked at RM 52 (Ryden 2003). Initial retention was encouraging, and over-winter survival was high (spring captures = 62.5 – 62.7% of fall captures); survival between age-1 and age-2 based on recapture rates neared 100 percent (Archer et al. 2000). Because of this initial success, an augmentation plan began in 2002 with a goal of stocking and monitoring 300,000 age-0 Colorado pikeminnow at RM 180.2 and RM 158.6 for seven years. A total of 1,781,154 Colorado pikeminnow were stocked into the San Juan River between 2002 and 2007 (Ryden 2008). Target stocking numbers were exceeded in 2007 with 475,970 age-0 fish stocked (target 300,000) and 3,256 age-1 fish stocked (target 3,000) (Ryden 2008). The target for age-1 fish was also exceeded in 2008 with 4,857 fish stocked (Furr and Davis 2009). Although capture of age-4 and older Colorado pikeminnow is rare (Ryden 2008), the capture of an age-11 Colorado pikeminnow that was stocked in 1996 as an age-0 fish (Davis and Furr 2008) indicates that at least some of the stocked fish are surviving to reproductive age. In addition to augmentation, ongoing recovery efforts include mimicry of a natural hydrograph, adult and larval fish monitoring, habitat and water quality monitoring, control of non-native species, and removal of migration barriers.

In 2003, the fish passage at the PNM weir was finished and put into operation. During the summer of 2003 nine Colorado pikeminnow used the fish passage (Lapahie 2007). One of the goals of the Program is the expansion of range of Colorado pikeminnow and removal of barriers to migration (SJRIP 1995). The removal of the Cudei diversion dam and construction of fish passage at the Hogback diversion dam in 2001 and the documented use of the PNM weir has provided opportunity for use of this upper portion of the river by Colorado pikeminnow, an important step toward recovery.

At the time of listing, few Colorado pikeminnow remained in the San Juan River as a result of human impacts. Since the initiation of the Program, Colorado pikeminnow numbers have increased, primarily due to an aggressive augmentation program. The species' long-term viability remains uncertain because of competition and predation from non-native fishes, water quality issues, the uncertainty surrounding the changes that climate change will bring to the San Juan River basin, and the limited habitat in the relatively short reach between Navajo Dam and Lake Powell.

Razorback sucker

As described for Colorado pikeminnow, the construction of Lake Powell and Navajo Reservoir resulted in the direct loss of approximately 161 km (100 mi) of habitat in the San Juan River for razorback sucker. Since closure of Navajo Dam in 1963, the accompanying non-native fish eradication program, physical changes associated with the dam, and barriers to movement, razorback sucker have been eliminated from the San Juan River above Navajo Dam. In the first 10 km (6.2 mi) below Navajo Dam, summer water temperatures are colder and the cool, clear water has allowed development of an intensively managed blue-ribbon trout fishery to the exclusion of most native species, including razorback sucker (Miller and Ptacek 2000).

From 1991 to 1997, no wild adult razorback suckers were collected in the San Juan River and only one was caught during studies conducted in the late 1980s (Holden 2000). Beginning in May 1987, and continuing through October 1989, complementary investigations of fishes in the San Juan River were conducted in Colorado, New Mexico, and Utah (Platania 1990, Platania et al. 1991). In 1987, a total of 18 adult razorbacks were collected (six were recaptured once) on the south shore of the San Juan arm of Lake Powell (Platania 1990, Platania et al. 1991). These fish were captured near a concrete boat ramp at Piute Farms Marina and were believed to be either a spawning aggregation or possibly a staging area used in preparation for migration to a spawning site. Of the 12 razorback suckers handled in 1987, 8 were ripe males and 4 specimens were females that appeared gravid.

In 1988, a total of 10 razorback suckers were handled at the same general location, 5 of which were in reproductive condition (Platania et al. 1991). Six of the 10 individual specimens in the 1988 samples were recaptures from 1987. Also in 1988, a single adult tuberculate male razorback sucker was captured in the San Juan River near Bluff, Utah (RM 80) (Platania 1990, Platania et al. 1991). This was the first confirmed record of this species from the main stem San Juan River. The presence of this reproductively mature specimen suggested that razorback suckers were attempting to spawn within the riverine portion of the San Juan drainage and the collection of larval razorback sucker indicates that stocked individuals are spawning (Brandenburg and Farrington 2008). However, no wild razorback suckers have been documented recruiting to the adult population in the San Juan River. A Schnabel multiple-census population model estimated that there were 268 razorback suckers in the San Juan River from RM 158.6 to 2.9 in October 2000 (Ryden 2001). This population estimate refers to stocked razorback sucker.

Experimental stocking of razorback sucker occurred between 1994 and 1996 and a total of 942 fish between 100-482 mm total length (TL) were stocked into the river. The Program initiated a five-year augmentation program for the razorback sucker in 1997 (Ryden 1997). Between September 1997 and November 2001, 5,890 subadult razorback suckers were stocked below Hogback Diversion Dam (RM 158.5). During interim stocking years in 2002 and 2003, only 1,027 razorback suckers were stocked into the San Juan River. In 2004, the Program initiated an augmentation program to stock 11,400 age-2 razorback sucker in the river for 8 years and while the stocking goal has not been achieved in all years, in 2006 and 2007, 18,793 and 22,836 razorback sucker were stocked into the San Juan River, respectively. These were the first two consecutive years that the target stocking number for razorback sucker (target = 11,400 fish) were met or exceeded. Approximately 13,800 of the fish in 2007 were less than the target stocking size of 300 mm (11.8 in) TL, and approximately 9,000 fish met the target size. The goal was meet again in 2009 with 12,439 razorback sucker stocked.

Fish that were stocked in 1995 are still being collected during annual sampling (Ryden 2008). Larval razorback suckers have been collected each year since 1998, indicating that the stocked fish are successfully spawning in the San Juan River (Brandenburg and Farrington 2008). Razorback sucker spawning aggregations have been identified at RM 100.2 in 1997, 1999, and 2001 (Ryden 2004), at RM 17.6 in 2002 (Ryden 2004), and at RM 154.2 in 2004 (Ryden 2005). In 2007, 207 razorback suckers stocked over the life of the Program were collected during annual adult monitoring (Ryden 2008). Their sizes ranged from 221 – 516 mm (8.7 – 20.3 in) TL (age-1 to15) (Ryden 2008). Razorback sucker were captured from RM 170.0 to RM 7. These results indicate the augmentation program has been successful in increasing the number of razorback sucker in the San Juan River in a relatively short time.

Factors Affecting the Species within the Action Area

Colorado Pikeminnow and Razorback Sucker

The San Juan River is a tributary to the Colorado River and drains a basin of approximately 25,000 mi^2 (65,000 km^2) located in Colorado, New Mexico, Utah, and Arizona (Reclamation 2003). From its origins in the San Juan Mountains of southwestern Colorado (at an elevation exceeding 13,943 ft) (4,250 m), the river flows westward through New Mexico, Colorado, and into Lake Powell, Utah. The majority of water that feeds the 345 mi (570 km) of river is from the mountains of Colorado. From a water resources perspective, the area of influence for the proposed project begins at the inflow areas of Navajo Reservoir and extends west from Navajo Dam approximately 224 mi (359 km) along the San Juan River to Lake Powell. The dam is operated and maintained by Reclamation (Reclamation 2003). The major perennial tributaries in the project area are the Los Pinos, Piedra, Navajo, Animas, La Plata, and Mancos Rivers, and McElmo Creek. There are also numerous ephemeral arroyos and washes that contribute little flow but large sediment loads to the San Juan River.

As recognized in the Final Environmental Impact Statement (EIS) for Navajo Reservoir Operations (Reclamation 2003), changes in biodiversity associated with the historical San Juan River occurred when Navajo Dam was placed into operation. The reservoir physically altered the San Juan River and surrounding terrain and modified the pattern of flows downstream. Similar to rivers downstream of other dam operations in the southwestern United States, the San Juan River became clearer due to sediment retained in the reservoir, and the water became colder, because it is released from a deep pool of water. The EIS states that all species of plants and animals that existed along the river channel were affected to varying degrees. The disruption of natural patterns of flow caused changes to the vegetation along the riverbanks by altering the previously established conditions under which the plants reproduced and survived.

Navajo Dam regulates river flows, provides flood control, and contributes to recreational and fishery activities (Reclamation 2003). In addition to the changes caused to the river by dam operations, the EIS recognized that there were changes to how the lands in the area were used. Irrigation water provided by Navajo Dam contributed to agriculture being practiced on a large scale. The reservoir stores water for the Navajo Indian Irrigation Project (NIIP), the Hammond Irrigation Project, and various municipal and industrial uses making it possible to nearly double the amount of irrigation in the basin. At present, the NIIP diverts an annual average of approximately 160,000 acre-feet (af) from the reservoir for irrigation south of Farmington, New Mexico (Reclamation 2003). In the future, this use is expected to approximately double (Reclamation 2003). This will further affect the river and the native species dependent on the river both directly, through flow diversions, and indirectly, through changes in water quality, as a result of the water acquiring metals, salts, pesticides, and fertilizers from the irrigated lands' return flows to the river (Reclamation 2003).

In addition to the effects of operating Navajo Dam, over the last century the San Juan River has experienced diversions for municipal use, resulting in a variety of return flows to the river, including industrial waste, stormwater runoff, and discharges from sewage treatment plants. Compounding these changes has been the intentional and non-intentional introduction of non-native species of fish that compete with and predate on native species (Reclamation 2003).

Although there are impacts to the river ecosystem from dam construction itself, dams have many impacts that continue after the structure is complete. Dams affect the physical, chemical, and biological components of a stream ecosystem (Williams and Wolman 1984, Service 1998, Collier et al. 2000, Mueller and Marsh 2002). Some of these effects include a change in water temperature, a reduction in lateral channel migration, channel scouring, blockage of fish passage, transformation of riverine habitat into lake habitat, channel narrowing, changes in the riparian community, diminished peak flows, changes in the timing of high and low flows, and a loss of connectivity between the river and its flood plain (e.g., Sherrard and Erskine 1991, Power et al. 1996, Kondolf 1997, Collier et al. 2000, Polzin and Rood 2000, Shields et al. 2000). Changes in water temperature, blockage of fish passage, transformation of riverine habitat into lake habitat, changes in the timing and magnitude of flows, climate change, changes in channel morphology, water quality, propagation and stocking, water depletion, diversion structures, and non-native fish are discussed in greater detail below.

Water temperature

The cold water released from Navajo Dam during the spring limits the potential spawning habitat of the endangered fishes in the San Juan River (USFWS 2009). Prior to dam construction water temperatures at Archuleta (approximately 10 km [6.1 mi] below the dam) were above the threshold spawning temperature of 20º C (68º F) for approximately two months (Holden 1999). Based on cumulative degree-days, spawning could have occurred at Archuleta by July 11 each year prior to dam closure (Lamarra 2007). Since dam construction, water temperature at that site is rarely over 15º C (59º F) and is too cold for successful Colorado pikeminnow spawning (Holden 1999, Cutler 2006, Lamarra 2007). The threshold temperatures for spawning at Shiprock (approximately 125 km [78 mi] below the dam) occur about two weeks later on average than prior to dam construction (Holden 1999, Lamarra 2007). Spawning is unlikely to occur from Navajo Dam to the confluence of the Animas River (approximately 72 km [45 mi] below the dam) and would be delayed for two weeks or more from the confluence with the Animas River down to Shiprock (Lamarra 2007).

Water temperatures at Shiprock before the construction of Navajo Dam were above 20º C (68º F) from approximately mid-June until mid-September (Holden 1999). Projected temperatures at Shiprock from 1993 – 1996 were above 20º C (68º F) for more than one month (August) (Holden

1999). Because fish are cold-blooded, their metabolism and growth depend on water temperature. The amount of food eaten, assimilation efficiency, and time to sexual maturity are affected by temperature (Lagler et al. 1977). Cold water typically decreases food consumption, assimilation efficiency, and growth rate, and increases the time to sexual maturity (Lagler et al. 1977).

Development time of Colorado pikeminnow and razorback sucker embryos is inversely related to temperature, and survival is reduced at temperatures that depart from 20º C (68ºF) (Bulkley et al. 1981, Hamman 1981, Bestgen 2008). Marsh (1985) found that for razorback suckers, time to peak hatch was nine days at 15ºC (59ºF) and 3.5 days at 25ºC (77ºF) and that the percent of eggs hatched was highest at 20ºC (68ºF). Bestgen (2008) found that fastest growth of razorback sucker occurred at 25.5ºC (77.9ºF). Fast larval growth may be linked to higher survival rates because the faster the larval fish grow, the less time they are highly susceptible to predation.

All Colorado pikeminnow eggs tested died at incubation temperatures of 15ºC (59ºF) or lower, and survival and hatching success were maximized near 20º C (68º F) (Marsh 1985). Bestgen and Williams (1994) found a relatively wide range of acceptable incubation temperatures above 18ºC (64.4 ºF). In addition, Bestgen et al. (2006) found that early hatching Colorado pikeminnow larvae in the Green River were almost twice the size of late hatching ones because they had more time to grow.

Because the combination of a suitable spawning bar (an area of sediment-free cobbles) and suitable temperatures occur low on the San Juan River at the Mixer, there is a greater chance that larval fish will drift into Lake Powell and be lost from the population. Dudley and Platania (2000) found that drifting larval Colorado pikeminnow would be transported from the Mixer to Lake Powell in as little as three days. For those larval fish not carried into Lake Powell, a delay in spawning (which reduces the amount of time YOY have to grow before winter) and overall colder water temperatures (resulting in slower growth) could lead to smaller, less fit YOY and reduce survival (USFWS 2009). While this reasoning is biologically sound, because there are so few Colorado pikeminnow in the San Juan River, the consequences of lower water temperatures on survival and recruitment of Colorado pikeminnow have not been tested for this river. There is speculation that the large volume of cold water in the upper Green River may be a major reason why larval Colorado pikeminnow drift so far downstream (Holden 2000). The same pattern may also occur on the San Juan River.

Cold water released from Navajo Dam has affected razorback sucker and Colorado pikeminnow in a number of ways. Water temperatures that were once suitable for spawning for Colorado pikeminnow near Archuleta are no longer suitable, and, if spawning were to occur near Shiprock, it would be delayed by approximately two weeks compared to pre-dam conditions. A delay in spawning reduces the amount of time that larval fish have to grow before winter, and colder temperatures reduce growth rate, increasing the amount of time that the larval fish are highly susceptible to predation.

Blockage of fish passage

Like other major dams on the Colorado River and its tributaries, Navajo Dam blocked all fish passage. While native fish once could move unimpeded from the San Juan River into the Colorado River and its tributaries, they are now confined to a relatively short reach of 362 km (225 mi) between Lake Powell and Navajo Dam. If adverse conditions occur (extreme low flow, extreme high flow, unfavorable temperatures or water quality) the fish cannot escape or seek refuge in the Colorado River as they once could. Razorback sucker and Colorado pikeminnow that may have been trapped above the reservoir have all died or were killed during treatment with rotenone (Olson 1962, Holden 1999). In addition to the major dams, diversion structures constructed in the San Juan River have also created barriers to fish passage.

Ryden and Pfeifer (1993) identified five diversion structures (Cudei, Hogback, FCPP, SJGS [PNM weir], and Fruitland Irrigation Canal diversions) between Farmington, New Mexico, and the Utah state line that potentially acted as barriers to fish passage at certain flows. When radio telemetry studies were initiated on the San Juan River in 1991, only one radio-tagged Colorado pikeminnow was recorded moving upstream past one of the diversions. In 1995, an adult Colorado pikeminnow moved above the Cudei Diversion and then returned back downstream (Miller and Ptacek 2000). Other native fish had been found to move either upstream or downstream over all five of the weirs (Buntjer and Brooks 1997, Ryden 2000a). In 2001, Cudei Diversion (RM 142) was removed from the river and Hogback Diversion (previously an earth and gravel berm structure), which had to be rebuilt every year, was made into a permanent structure with non-selective fish passage. Channel catfish that were tagged downstream of the Hogback Diversion in spring and summer 2002 were recaptured upstream of the structure in summer and fall 2002. It is likely that Colorado pikeminnow, razorback sucker, and other native fishes can negotiate the ladder. The removal of Cudei Diversion and installation of the fish ladder at Hogback Diversion improved access for native fishes over a 39.4 km (24.5 mi) reach of river.

Until 2003, the PNM weir (RM 166) was also a barrier to fish passage. The PNM selective fish ladder was completed and has been operational since 2003. This has allowed passage past that structure by Colorado pikeminnow and razorback suckers. From 2003 to 2007, 65,596 native fish used the passage including 27 Colorado pikeminnow and 21 razorback suckers (Lapahie 2007). However, the FCPP Diversion at RM 163.3 can act as a fish barrier when the control gate for the structure is closed (Holden and Masslich 1997). Above the PNM weir, at the Fruitland Irrigation Canal Diversion (RM 178.5), model results suggest that the rock dam structure does not significantly hinder fish passage, expect perhaps at very high discharges (8,000 cubic feet per second [cfs] and greater) (Stamp and Golden 2005).

Dams have fragmented razorback sucker and Colorado pikeminnow habitat throughout the Colorado River system. Within the San Juan River, fish passage was once impeded by five instream structures. One of these structures has been removed, two have been equipped with fish passage structures, and two remain as impediments to fish passage for part of the year depending on flow. However, no remaining structures are complete barriers within critical habitat but there is a waterfall downstream of Clay Hills Crossing (RM 2.9) that prevents non-native fish and endangered fish that wash over the waterfall from returning to the San Juan River. Within the San Juan River Colorado pikeminnow and razorback sucker can potentially navigate from Clay Hills Crossing, past the Animas River, and up to the Hammond Diversion Dam, a total of approximately 338 km (210 mi).

Transformation of riverine into lake habitat

Lake Powell inundated the lower 87 km (54 mi) of the San Juan River, and Navajo Reservoir inundated another 43 km (27 mi). The two reservoirs reduced the potential range and habitat for the two endangered fishes from about 523 km (325 mi) to 362 km (225 mi) and inundated potential Colorado pikeminnow spawning areas in the upper San Juan River (Holden 2000). Although the loss of habitat is substantial, several other problems for native fishes resulted from the creation of lakes. The larvae of razorback sucker and Colorado pikeminnow drift downstream until they find suitable nursery habitat (backwaters or other low velocity areas) (Holden 2000). Because the river has been truncated 87 km (54 mi) on the lower end, there are many fewer stream miles available for nursery habitat. Some Colorado pikeminnow in the Green and Colorado River systems drift up to 322 km (200 mi) from spawning areas before finding nursery habitat, while others use nursery areas only a few miles below the spawning areas (Trammell and Chart 1999). The majority of YOY Colorado pikeminnow that have been collected in the San Juan River have been at the inflow to Lake Powell (Buntjer et al. 1994, Lashmett 1994, Archer et al. 1995, Platania 1996). Because of the many predators present and lack of suitable habitat, it is unlikely that larvae survive in Lake Powell.

In 1961, prior to the filling of Navajo Dam, New Mexico Department of Game and Fish used rotenone “to eliminate trash fish species” from the San Juan River (120 km [75 mi]), among others (Olson 1962). Fourteen species of fish were eliminated in the treated section of river (Olson 1962). There were three drip stations on the San Juan River that effectively killed the majority of the fish from the Colorado state line, near Rosa, New Mexico, down to Fruitland, approximately 64 km (40 mi) below Navajo Dam (Olson 1962). Colorado pikeminnow was included in the list of fish eliminated (Olson 1962). The number of fish killed was not recorded because of the large scale of the project (Olson 1962). The intent of the project was to eliminate competition and predation between native fish and the non-native sport fishery that was to be established in Navajo Reservoir.

Lake Powell is populated by several fish species not native to the Colorado River that are predators on native fish. As mentioned above, larval native fish that drift into Lake Powell are almost certainly lost to predation by largemouth bass, smallmouth bass, striped bass, walleye, or crappie (*Pomoxis* sp.). Striped bass migrate up the San Juan River as far upstream as the PNM weir (RM 166) in some years (Davis 2003). Adult striped bass are piscivorous (Moyle 1976). In 2000, 432 striped bass were captured during monitoring trips for Colorado pikeminnow and during trips to remove non-native fishes (Davis 2003). The contents of 38 striped bass stomachs were analyzed and native suckers were found in 41 percent (Davis 2003). Clearly, this migratory predator is a threat to both YOY and juvenile native fish.

<u>Changes in the timing and magnitude of flows</u>

Natural flow regimes are essential to the ecological integrity of large western rivers (Service 1998) and for the maintenance or restoration of native aquatic communities (Lytle and Poff 2004, Propst and Gido 2004, Propst et al. 2008). The flow regime works in concert with the geomorphology of the basin to establish and maintain the physical, chemical, and biological components of a stream ecosystem (Williams and Wolman 1984, Allan 1995, Service 1998, Collier et al. 2000, Mueller and Marsh 2002). With a natural flow regime, streams and rivers retain those ecological attributes with which the native fauna evolved. Some of these ecological attributes and biological components include the native aquatic communities, water temperature, channel formation and migration, the riparian community, connectivity between the river and its flood plain (Sherrard and Erskine 1991, Allan 1995, Power et al. 1996, Kondolf 1997, Polzin and Rood 2000, Collier et al. 2000, Shields et al. 2000). Equally important is that a natural flow regime is less likely to provide the conditions suitable for the establishment and colonization of systems by non-native species that may have evolved under a different set of biotic and abiotic conditions (Propst et al. 2008).

Typical of rivers in the southwest, the San Juan River was originally characterized by large spring snowmelt peak flows, low summer and winter base flows, and high-magnitude, short-duration summer and fall storm events (Holden 1999). The completion of Navajo Dam in 1962 and subsequent dam operations through 1991 substantially altered the natural hydrograph of the San Juan River (Holden 1999). Operations appreciably reduced the magnitude and a changed the timing of the annual spring peak. Historically, flows in the San Juan River were highly variable and ranged from a low of 44 cfs in September 1956 to a high of 19,790 cfs in May 1941 (mean monthly values) at the U.S. Geological Survey Station gauge near Shiprock. The flows for this period do not necessarily represent a “natural” condition because water development began in the basin near the turn of the century, and many irrigation projects that diverted and depleted water from the San Juan River were already in place. For the 49 years of record prior to Navajo Dam, a peak spring flow greater than 15,200 cfs occurred 13 times (25 percent of the time). The highest spring peak flow recorded (daily mean) was 52,000 cfs (June 30, 1927). In wet years, dam releases began early to create space in the reservoir to store runoff (Holden

1999). The peak discharge averaged 54 percent of the spring peak of pre-dam years. The highest mean monthly flow was 9,508 cfs (June 1979), a decrease of more than 10,000 cfs compared to pre-dam years. Base flows were substantially elevated in comparison to pre-dam years. The median monthly flow for the base flow months (August – February) averaged 168 percent of the pre-dam period (Holden 1999). Minimum flows were elevated and periods of near-zero flow were eliminated with a minimum monthly flow during base-flow periods of 250 cfs compared to 65 cfs for the pre-dam period (Holden 1999). The hydrograph was flatter during this time period.

From 1991 to 1997, flows were manipulated by Reclamation in coordination with the Program to determine fish population and habitat responses when Navajo Dam was operated to mimic a natural hydrograph (Holden 1999). Reclamation's flexibility in managing flows and the technical input from the Program during this period of experimental flow manipulations allowed researchers an opportunity to develop flow recommendations. A mimicked natural hydrograph was maintained during this period of experimental flows. The research flow period was more similar to the years that followed (1998 to present) than they were prior to 1991. For this reason, the years from 1991 to present were used to analyze the effects of Flow Recommendations developed by the Program on physical habitat and endangered fish populations.

Navajo Dam has been operated to meet the Flow Recommendations since their publication in 1999 (Holden 1999). A natural hydrograph has been mimicked but not replicated. Achieving peak magnitudes is no longer possible because of release restrictions at the dam. The mimicked natural hydrograph created by the Flow Recommendations is an improvement over the pre-1991 hydrograph. With the reoperation of Navajo Dam, the native fish receive the proper cues at the proper times to trigger spawning more frequently, and more suitable habitat is available at the proper times for young fish.

<u>Climate change</u>

Warming of the earth's climate is "unequivocal," as is now evident from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and the polar ice cap, and rising sea levels (IPCC 2007). The Intergovernmental Panel on Climate Change (IPCC 2007) described changes in natural ecosystems with potential widespread effects on many organisms, including freshwater fish. The potential for rapid climate change poses a significant challenge for fish and wildlife conservation. Species' abundance and distribution are dynamic and dependent on a variety of factors, including climate (Parmesan and Galbraith 2004). Typically, as climate changes, the abundance and distribution of fish and wildlife change. In highly modified systems like the San Juan River, where the Colorado pikeminnow and razorback sucker populations are trapped between two dams, the ability to disperse to other, potentially more favorable habitats has been lost. Highly specialized or endemic species are likely to be most susceptible to the stresses of changing climate. Based on these findings and other similar studies, the U.S. Department of Interior (DOI) requires agencies under its direction to consider potential climate change effects as part of their long-range planning activities.

Climate change is of particular concern in the Colorado River basin. The Colorado River Compact governs water allocations between the upper and lower Colorado River basins. It was signed in 1922, based on a short hydrological record of relatively high annual flows (Christensen and Lettenmaier 2006). Tree-ring reconstructions of Colorado River flows indicate that the gauged record covers only a small subset of the range of variability, and the basin's future hydrology may not reflect the relatively short gauged record (NRC 2007). Consequently, there is less water available to allocate than originally thought.

The Colorado River basin has warmed approximately 1.4°C (2.5°F) over the past century, with temperatures today at least 0.8°C (1.5°F) warmer than during the 1950 drought (NRC 2007, Lenart et al. 2007). Both in terms of absolute degrees and in terms of annual standard deviation, the Colorado River basin has warmed more than any region of the United States (NRC 2007). Increased air temperatures are expected to result in reduced runoff, even if precipitation were to increase. Additionally, increases in urban water demand will further stress supplies. Conflict over water is expected to increase, making it more challenging to maintain appropriate flows for endangered fishes.

Climate change may also affect the timing and magnitude of flows in the San Juan River (USFWS 2009). In the Colorado River basin, records document an annual mean air surface temperature increase of approximately 1.4°C (2.5°F) over the past century with temperatures today at least 0.8°C (1.5°F) warmer than during the 1950 drought (NRC 2007, Lenart et al. 2007). Udall and Bates (2007) found that multiple independent data sets confirm widespread warming in the West and the Colorado River basin has warmed more than any region of the United States (NRC 2007).

One expected outcome of increased air temperature is increased evaporation from Navajo Reservoir. An historical and ongoing adverse effect of Navajo Reservoir on the endangered fishes in the San Juan River is the evaporative loss of water; approximately 27,400 af are currently lost annually from the reservoir (Reclamation 2003). Water and air temperatures are important elements in calculating evaporation rate. Unless humidity increases and wind decreases at Navajo Reservoir because of climate change, an increase in air temperature will lead to increased evaporation loss from the reservoir, affecting the amount of water available for all uses (USFWS 2009). In addition, the Animas-La Plata project has started diverting water from the Animas River into Lake Nighthorse, a new reservoir that will be an additional source of evaporative loss from the system. Although an evaporative loss of approximately 2,700 af/yr from Lake Nighthorse is accounted for in calculating depletions for the project, additional increases due to climate change are not.

In addition to increased depletions due to evaporative losses, Hoerling and Eischeid (2006) project that in the Southwest, relative to data collected from 1990 to 2005, a 25 percent decline in stream flow will occur from 2006 to 2030 and a 45 percent decline will occur from 2035 to 2060. Seager et al. (2007) demonstrated that there is a broad consensus among climate models that the Southwest will get drier in the twenty-first century and that the transition to an even more arid climate is already under way. These models projected a decrease in runoff of eight to 25 percent. The Colorado River basinwide snow water equivalent is projected to decline by 13 to 38 percent from 2025–2085 (Christensen and Lettenmeier 2006). Ray et al. (2008) and Udall (2007) summarized several studies, which all point to an expected decline in runoff in the Colorado River basin. Although the San Juan River is not modeled independent of the entire Colorado River basin in these studies, as it is part of the system it is reasonable to expect that a similar pattern will occur.

The Flow Recommendations were developed based on the historical hydrograph. Spring flows from 2,500 to 10,000 cfs are scheduled to occur, on average, in intervals from two to 10 years, respectively (Holden 1999). A maximum of 5,000 cfs can be released from the gates at Navajo Dam. Releases from the dam are timed with spring runoff from the Animas River to meet the high target flows. Increased evaporation and decreased runoff would lead to less water available to meet all demands, which could potentially affect the magnitude of flows that can be released for the endangered fishes. It may become more challenging to meet the higher target flows in the future if Navajo Reservoir storage is reduced or runoff from the Animas River decreases. This is particularly important because when high flows are reduced in magnitude or frequency, non-native vegetation encroaches on the channel, causing channel habitat to simplify (Bliesner and Lamarra 2007). Habitat complexity is the desirable condition for Colorado pikeminnow and razorback sucker. Releasing high spring flows to maintain and create suitable habitat for the endangered fishes will continue to be an important element of the Flow Recommendations.

In the western United States, warming temperatures have resulted in a shift of the timing of spring snowmelt. Stewart et al. (2005) showed that timing of spring snowmelt and runoff in the western United States during the last five decades has shifted so that the major peak runoff now arrives one to four weeks earlier, resulting in less flow in the spring and summer. Rauscher et al. (2008) suggested that with air temperature increases of 3 – 5ºC (37 – 41ºF), snowmelt driven runoff in the western United States could occur as much as two months earlier than present. While it is reasonable to expect that runoff in the San Juan River is occurring earlier because of warmer air temperatures, there has been no analysis of the timing of spring runoff. However, Westfall and Bliesner (2008) looked at the predictions of several models using two emission scenarios and all predicted that by 2099, runoff in the San Juan River would occur approximately one month earlier than historical conditions. There is no documentation of how much earlier spring runoff is currently occurring, if at all, compared to the historical condition.

It is difficult to predict how a change in the timing of runoff will affect the endangered fishes. It appears that spawning is cued to temperature and fluctuations in snowmelt runoff (Service 2002a, b). It is unknown if day length plays a role in preparing the fish to spawn, if a minimum amount of time is required for gamete development, and how plastic the fish are in adjusting to new environmental conditions. Theoretically, the fish may not be able to adjust to an earlier spawning date, especially if it were one or two months earlier. However, if successful spawning occurs earlier, larval fish would have a longer growing season before winter. Because water temperatures in the San Juan River are colder than historical conditions in the summer (due to deep water releases from Navajo Reservoir), having a longer growing season could have a positive effect on recruitment of these fishes. The effects of earlier spring runoff on the fishes are unknown and should be monitored.

Climate change could increase Colorado pikeminnow and razorback sucker exposure to contaminants through two mechanisms. First, as stated above, it is anticipated that runoff will decrease (Udall 2007, Ray et al. 2008). If discharge decreases, contaminants will be more concentrated than they are currently. Second, with warmer air temperatures, evaporation of irrigation water on fields will increase, and return flows may decrease, increasing the concentration of contaminants such as selenium in the irrigation flows that return to the San Juan River. Consequently, Colorado pikeminnow and razorback sucker may be exposed to increasing concentrations of contaminants over time as a result of climate change.

Climate change is occurring and will continue to increase air temperatures in the Colorado River basin (USFWS 2009). The most likely consequences of warmer air temperatures are increased evaporation and evapotranspiration and decreased runoff, as well as earlier spring runoff. To the extent that climate change reduces the amount of water available in the river, we anticipate that negative impacts could occur to the endangered fishes because water demand for human uses will increase. Because water allocations in the San Juan River were based on flows recorded during a relatively wet period, if climate change leads to a long-term decline in runoff, meeting all the human demands and the needs of the Colorado pikeminnow and razorback sucker through the Flow Recommendations could become challenging in the future.

<u>Changes in channel morphology</u>

The quantity and timing of flows influence how the channel and various habitats are formed and maintained. As channel width decreases, water velocity increases, and the amount of low velocity habitats important to the early life stages of the endangered fish decreases (Service 1998). Between the 1930s and 1950s, the channel narrowed by an average of 29 percent between the present day site of Navajo Dam (RM 224) and RM 67 (Holden 1999). From 1930 to 1942, suspended sediment load was approximately 47.2 million tons/year (Holden 1999). Between 1943 and 1973, suspended sediment load dropped by half to 20.1 million tons/year

(Holden 1999). The 1930s aerial photography shows a sand-loaded system; where the channel was not confined, the river was broad during high flows and braided during low flows (Holden 1999).

Channel narrowing before 1962 was most likely due primarily to the reduction in sediment load, while channel narrowing in later years (after 1962) corresponds to the modification of flows by Navajo Dam and the introduction and encroachment of Russian olive (Holden 1999). Reduced peak flows after Navajo Dam was completed (1962 to 1991) exacerbated the growth of exotic riparian vegetation (primarily saltcedar and Russian olive). These non-native trees armored the channel banks and contributed to the creation of a narrower channel (Bliesner and Lamarra 1994). Modification of flows and non-native vegetation led to more stabilized channel banks, a deeper, narrower main channel, and fewer active secondary channels (Holden 1999). Total wetted area over time, normalized for flow at mapping, shows a trend of total wetted area decreasing by about 10 percent (Bliesner and Lamarra 2007). This channel simplification has been attributed to extended drought and encroachment of Russian olive and saltcedar. The encroachment is exacerbated during dry periods when flow in secondary channels is inadequate to remove young vegetation or prevent establishment of new vegetation. Once the vegetation is established, it becomes an effective trap for fine sediments by creating increased channel roughness and low boundary velocities. Once vegetation is established on main channel margins and within secondary channels, it is more difficult for those channels to be flushed and for new ones to be created during high flow years (Bliesner and Lamarra 2007).

Since 1992, when a natural hydrograph was mimicked, peak flows have been higher than in the pre-experimental research flow period (prior to 1991). Backwater habitat, an important nursery area for fish, reached a low in 2003 at about 20 percent of the peak value (Bliesner and Lamarra 2007). The trend reversed in 2004, and in 2005 more backwaters were recorded. There was no increase in 2006, a dry year with a small release from the reservoir (Bliesner and Lamarra 2007). Other low velocity habitat (i.e., pools, eddies), slackwater, and shoal areas have not changed significantly since 1992 (Bliesner and Lamarra 2007).

Channel complexity is an important component of razorback sucker and Colorado pikeminnow habitat. One measure of channel complexity is the number and area of islands present. Between 1950 and 1960 there was a large decrease in island area (Bliesner and Lamarra 2007). Vegetation encroached on the channel and long secondary channels were cut off as the floodplain stabilized. The increase in vegetation during this period coincided with a long-term drought, which contributed to channel simplification (Bliesner and Lamarra 2007). Between 1960 and 1988, island area increased to the levels that were present in 1934 (Bliesner and Lamarra 2007). The 10 years prior to 1988 were the wettest on record, so although saltcedar and Russian olive continued to increase in the floodplain, the large flows opened secondary channels, creating large islands. Since 1992, there has been a cumulative reduction in island count at low flow of about 25 percent (Bliesner and Lamarra 2007). The island count, normalized for flow at mapping, shows a significant downward trend with time, indicating channel simplification. The greatest loss of islands has occurred in Reach 5 (RM 131 to 154). Channel simplification is of particular concern here because Reach 5 includes known spawning habitat for Colorado pikeminnow.

Despite the habitat changes that have occurred in the San Juan River, at current population levels, habitat does not appear to be a limiting factor for either the razorback sucker or Colorado pikeminnow adults (Holden 2000). However, the habitat needs of larval fish have not been thoroughly explored, and further research may find specific habitat needs that are not being met or that are limiting (Holden 2000).

There is a trend towards channel simplification, channel narrowing, reduced wetted area, and loss of islands (Bliesner and Lamarra 2007) in the San Juan River. Although channel morphology has been monitored for a relatively short time and the recent drought and lack of high flows may have an overriding influence on channel-forming processes, it appears that flow manipulation alone may be inadequate to restore channel complexity.

Water quality

Abell (1994) conducted a contaminants review and identified irrigation and mineral extraction, processing, and use as major sources of contaminants in the San Juan River basin. Comparison to water quality standards was cumbersome, as both the level of protection and the criteria for protection varied according to the various water uses and the laws of each state (New Mexico, Colorado, and Utah) through which the San Juan River flowed. According to the New Mexico Water Quality Control Commission's (1992) evaluation, none of the surface waters of the San Juan River basin in New Mexico had fully supported uses. Agriculture and resource extraction activities were the most common sources of nonsupport, with metals and siltation the most common causes of nonsupport (Abell 1994). According to the Colorado Water Quality Control Division’s 1992 report, portions of all major tributaries to the San Juan River in Colorado failed to fully support their uses (Abell 1994). Narraguinnep, McPhee, and Navajo Reservoirs were each found to partially support their uses, all due to mercury levels in fish. Of the nineteen river or stream reaches whose uses were impaired, metals were cited as contaminants in twelve, sediment in eight, and salinity in three. Within the San Juan River basin in Utah, the Utah Division of Water Quality had sampled segments of Montezuma Creek and the San Juan River and found water quality impairments of temperature, dissolved oxygen, copper, iron, and zinc. Surface and ground water quality studies in the Animas, La Plata, Mancos, and San Juan River drainages were also described, as were other water quality concerns (Abell 1994).

Changes in water quality and contamination of associated biota are known to occur within Reclamation projects in the San Juan drainage (i.e., irrigated lands along the San Juan, Pine, and

Mancos Rivers) where return flows from irrigation make up a portion of the river flow (Sylvester et al. 1988). Increased loading of the San Juan River and its tributaries with heavy metals, elemental contaminants (such as selenium, salts, polycyclic aromatic hydrocarbons [PAHs]), and pesticides have degraded San Juan River water quality in Colorado pikeminnow critical habitat (Abell 1994; Wilson et. al. 1995; Holden 1999). In particular, mercury and selenium levels have been identified as a concern in the San Juan River basin, along with other contaminants (Abell 1994; Simpson and Lusk 1999).

Information on existing water quality in the San Juan River has been derived from data gathered by various bureaus of DOI as part of its National Irrigation Water Quality Program investigation of the San Juan River area in Colorado, New Mexico, and Utah, results from Reclamation's water quality data for the Animas-La Plata Project, and ongoing contaminant monitoring and research conducted as part of the Program. Thomas et al. (1998) found that concentrations of most potentially toxic elements analyzed from the San Juan River drainage in their study, other than selenium, were generally not high enough to be of concern to fish, wildlife, or humans.

Selenium and mercury in the Four Corners area comes from natural and anthropogenic sources, and loading of these elements into this ecosystem has been ongoing for quite some time. Surface and groundwater quality in the Animas, La Plata, Mancos, and San Juan River drainages have become significant concerns (Abell 1994). Changes in water quality and contamination of associated biota are known to occur in Reclamation projects in the San Juan drainage (specifically associated with irrigated lands along the San Juan, Pine, and Mancos Rivers) where return flows from irrigation make up a portion of the river flow (Sylvester et al. 1988). Increased loading of the San Juan River and its tributaries with heavy metals, elemental contaminants (such as selenium, salts, and PAHs), and pesticides have degraded water quality of the San Juan River within critical habitat for the endangered fish (Abell 1994, Wilson et al. 1995, Simpson and Lusk 1999).

<u>Propagation and stocking</u>

Colorado pikeminnow were thought to be extirpated from the San Juan River in the early 1980s, largely due to human impacts on the Colorado and San Juan Rivers (Tyus et al. 1982). Surveys conducted from 1987 to 1989 revealed that Colorado pikeminnow were still present in the San Juan River, although in very low numbers (Platania et al. 1991). Because of these extremely low numbers of wild Colorado pikeminnow and poor recruitment into the population, a propagation and stocking program was initiated to augment Colorado pikeminnow numbers. When the Program was established in 1992, one of the key elements for recovery and conservation was the protection of genetic integrity, management, and augmentation of populations of the endangered fish.

Experimental stocking of 100,000 YOY Colorado pikeminnow was conducted in November

1996 to test habitat suitability and quality for young life stages (Lentsch et al. 1996). Monitoring in late 1996 and 1997 found these fish scattered in suitable habitats from just below the upstream stocking site at Shiprock to the inflow of Lake Powell. During the fall of 1997, the fish stocked in 1996 were caught in relatively high numbers and exhibited good growth and survival rates (Holden and Masslich 1997). In August 1997, an additional 100,000 YOY Colorado pikeminnow were stocked in the river. In October 1997, the YOY stocked two months previously were found distributed below stocking sites and in relatively large numbers nearly ten miles above the Shiprock stocking location. On average, the 1997 stocked fish were smaller than those stocked in 1996 and were able to move about the river to find suitable habitats (Holden and Masslich 1997). Because of the initial success of the stocked fish, Colorado pikeminnow have been stocked every year since 1996.

A total of 1,781,154 Colorado pikeminnow were stocked into the San Juan River from 2002 to 2007 (Ryden 2008). In 2007, target stocking numbers were exceeded for both age-0 and age-1 Colorado pikeminnow, with 475,970 and 3,256 fish stocked, respectively (targets were 300,000 and 3,000, respectively). Juvenile and adult Colorado pikeminnow from several size classes are now captured in the San Juan River, indicating that there has been survival of the stocked fish from several years (Ryden 2008). The SJRRIP augmentation program has been successful in increasing the number of Colorado pikeminnow in the San Juan River in a relatively short time, increasing the number of fish much faster than if augmentation had not taken place.

Although evidence suggests that razorback suckers were once abundant in the San Juan River at least up to the confluence with the Animas River (Platania and Young 1989), at present wild razorback suckers, if they still exist, are extremely rare in the river. Even with intensive sampling, only one adult was captured in the river from 1987 to 1989, and 292 collections of larval fish during that same time recovered no razorback suckers (Platania et al. 1991). Because of the limited number of razorback sucker and the lack of recruitment, the Program initiated a five-year augmentation program to supplement the population (Ryden 1997).

Between 1994 and 2007, a total of 54,472 hatchery and pond raised razorback suckers were stocked into the San Juan River (Ryden 2008). In 2007, 22,836 razorback suckers were stocked, the second consecutive year that the target stocking number (11,400 fish) for razorback sucker was met or exceeded. Razorback suckers that have been in the river for six or more overwinter periods have been collected every year since 2001 (Ryden 2008). Larval razorback suckers have been collected each year since 1998, indicating that the stocked fish are successfully spawning in the San Juan River (Brandenburg and Farrington 2008). The augmentation program has been successfully increasing the number of razorback sucker in the San Juan River in a relatively short time, increasing the number of fish much faster than if augmentation had not taken place.

Water depletions

As discussed previously, natural flow regimes are essential to the ecological integrity of large western rivers (Service 1998) and for the maintenance or restoration of native aquatic communities (Lytle and Poff 2004, Propst and Gido 2004, Propst et al. 2008). The flow regime works in concert with the geomorphology of the basin to establish and maintain the physical, chemical, and biological components of a stream ecosystem (Williams and Wolman 1984, Allan 1995, Service 1998, Collier et al. 2000, Mueller and Marsh 2002). Depletions play a major role in limiting the amount of water available for achieving the Flow Recommendations.

Significant depletions and redistribution of flows of the San Juan River have occurred because of other major water development projects, including the NIIP and the San Juan-Chama Project. At the current level of development, average annual flows at Bluff, Utah, already have been depleted by 30 percent (Holden 1999). By comparison, the Green and Colorado Rivers have been depleted approximately 20 percent (at Green River) and 32 percent (at Cisco), respectively (Holden 1999). These depletions have likely contributed to the decline in Colorado pikeminnow and razorback sucker populations (Service 1998). Depletions are expected to increase as full development of water rights and water projects occur. To the extent that water is exported out of the basin (San Juan-Chama Project) or consumptively used (e.g., evaporation from fields, irrigation canals, reservoir surface) it is not available to maintain flows within the river. Maintenance of streamflow is essential to the ecological integrity of large western rivers (Service 1998).

Water depletion projects that were in existence prior to November 1, 1992, are considered to be historic depletions because they occurred before the initiation of the SJRRIP. Projects that began after this date are considered new projects. On May 21, 1999, the Service determined through section 7 consultation that new depletions of 100 af or less, up to a cumulative total of 3,000 af, would not: 1) limit the provision of flows identified for the recovery of the Colorado pikeminnow and razorback sucker, 2) be likely to jeopardize the endangered fish species, or 3) result in the destruction or adverse modification of their critical habitat. Consequently, any new depletions under 100 af, up to a cumulative total of 3,000 af, may be incorporated under a 1999 BO for minor depletions under 100 af or less from the San Juan River Basin but would still require consultation.

Consultations contributing to the baseline depletions used reoperation of Navajo Reservoir in accordance with the Flow Recommendations as part of their section 7 compliance. Some of these projects have been completed (e.g., PNM Water Contract with Jicarilla Apache Nation), some are partially complete (e.g., NIIP), and some have not been fully implemented (e.g., Animas-La Plata Project). When these projects are fully implemented, the amount of water available for operational flexibility will decrease.

As discussed above under “Changes in the Timing and Magnitude of Flow,” it is anticipated that climate change will create additional depletions to the San Juan River in the future. The magnitude and timing of the depletions cannot be predicted with certainty at this time. However, increased air temperatures will increase evaporation from all water surfaces, increase plant evapotranspiration and decrease snow water equivalent, reducing the amount of water in the basin. As reviewed above, several studies project a decrease in stream flow from eight to 45 percent depending on the model used, the time frame, and the methods (Christensen and Lettenmeier 2006, Seager et al. 2007, Udall 2007, Ray et al. 2008). Although the San Juan River was not modeled independent of the entire Colorado River basin in these studies, based on the projections of the IPCC (in Christensen et al. 2007) for warmer temperatures and an increase in the frequency of hot extremes and heat waves, it is reasonable to expect that there will be a decrease in stream flow in the future.

As the San Juan basin water users move towards fully utilizing their respective water rights, the amount of water available for operational flexibility will decrease. We anticipate that climate change will place additional constraints on the amount of water available for operational flexibility.

Diversion structures

There are numerous points of diversion on the San Juan River for irrigation and energy production. In addition to acting as fish passage impediments (as discussed earlier), most of these structures do not have screens or other devices to prevent fish from entering (Holden 2000). Although anecdotal, Quartarone and Young (1995) presented many stories from senior citizens that recalled seeing or catching razorback suckers from irrigation ditches, sometimes in very large numbers. Trammell (2000) reported that after stocking 500,000 larval Colorado pikeminnow below Hogback Diversion structure, 63 larvae were collected from the Cudei Diversion canal. This number represented 0.013 percent of the total stocked, and the catch rate was 4.39 Colorado pikeminnow/100 m^3 of water sampled.

In December 2004, 140 Colorado pikeminnow in three size classes were caught in the Hogback Diversion (Platania and Renfro 2005). Most of the individuals (92 percent) were between 33 and 65 mm SL (1.3 – 2.5 in) that had been stocked in October 2004. Seven were between 130 and 187 mm SL (5.1 – 7.4 in) and four were 210 to 264 mm SL (8.3 – 10.4 in) (Platania and Renfro 2005). Colorado pikeminnow were caught from 0.5 to 17.8 canal miles from the diversion structure (Platania and Renfro 2005). In 2005, recently stocked Colorado pikeminnow were captured in the Hogback and Fruitland Diversion canals.

Colorado pikeminnow that enter diversion structures face an uncertain fate, although fish may find their way back to the river. The Program is analyzing entrainment at all of the diversion structures, and diversions that entrain fish will be addressed by the Program.

Non-native fish

Nearly 70 non-native fish species have been introduced into the Colorado River system over the last 100 years. Non-native fish in the San Juan River include rainbow trout, brown trout, striped bass, walleye, channel catfish, black bullhead, yellow bullhead (*Ameiurus natalis*), largemouth bass, smallmouth bass, green sunfish, longear sunfish (*Lepomis megalotis*), bluegill, white crappie (*Pomoxis annularis*), fathead minnow, red shiner, western mosquitofish, common carp, white sucker (*Catostomus commersonii*), white sucker-flannelmouth sucker hybrids, white sucker-bluehead sucker hybrids, threadfin shad (*Dorosoma petenense*), grass carp (*Ctenopharyngodon idella*), and plains killifish (*Fundulus zebrinus*) (Ryden 2000a, Buntjer 2003).

For more than 50 years, researchers have been concerned that non-native fishes have contributed to the decline of native fishes in the Colorado River basin (Service 1989). Non-native species are potential predators, competitors, and vectors for parasites and disease (Tyus et al. 1982, Lentsch et al. 1996, Pacey and Marsh 1999, Marsh et al. 2001). Because non-native fish are considered an important biological threat to Colorado pikeminnow and razorback sucker, control of non-native fishes through removal has become part of the Program. Recent adult monitoring reports show evidence that the non-native fish removal efforts are having a marked and measurable effect on the channel catfish and common carp populations in the San Juan River (Davis and Furr 2008). There is also an upward trend in both abundance and longitudinal distribution between both flannelmouth sucker and bluehead sucker that corresponds with the intensive non-native fish removal efforts that began in 2001.

Effects of the Action

'Effects of the action' means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). If the proposed action includes offsite measures to reduce net adverse impacts by improving habitat conditions and survival, the Service will evaluate the net combined effects of the proposed action and the offsite measures as interrelated actions.

'Interrelated actions' are those that are part of a larger action and depend on the larger action for their justification; 'interdependent actions' are those that have no independent utility apart from the action under consideration (50 CFR 402.02). Future Federal actions that are not a direct effect of the action under consideration, and not included in the environmental baseline or treated as indirect effects, are not considered in this BO.

Colorado Pikeminnow and Razorback Sucker and Their Designated Critical Habitat

Operation of the Hogback Irrigation Project results in an average annual depletion of 13,000 af from the San Juan River. This level of depletion is included in the hydrologic baseline for the San Juan River and does not impact Flow Recommendations. This continued depletion will not have an adverse affect of on the Colorado pikeminnow, razorback sucker, or their critical habitat. Because no construction or alterations will occur in the river as a result of the Hogback Fish Barrier, no other effects to critical habitat for Colorado pikeminnow and razorback sucker are expected. In 2002, a non-selective fish passage was constructed around the Hogback Diversion Dam to allow endangered fish to pass upstream of the diversion.

The diversion intake structure; however, has the potential to impinge or entrain adult, sub-adult, juvenile, or larval fish that could result in injury or death. The construction of the Hogback fish weir at the intake structure is expected to have an overall beneficial effect on Colorado pikeminnow and razorback sucker because the barrier is designed to return adult and sub-adult fish that enter the Hogback Canal to the San Juan River unharmed. While the fish barrier has been designed with sweeping velocities to minimize impingement, incidental take may still occur as larval fish may still become entrained in the Hogback Canal downstream of the fish barrier, resulting in incidental take of these individuals if they pass over the weir wall.

Indirect Effects

Indirect effects are those that are caused by, or result from, the proposed action, and are later in time, but are reasonably certain to occur. The continued operation of the Hogback Irrigation Project may lead to land use changes within the action area that could result in changes to air and water quality. Increased return flow from irrigated lands within the action area may lead to increased sediment, pesticide, nutrient, and selenium loading in the San Juan River. Increases in the population of the area around Shiprock, New Mexico could likely coincide with these land use changes.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions on endangered or threatened species or critical habitat that are reasonably certain to occur in the foreseeable future in the action area considered in this biological opinion. The Service is not currently aware of cumulative effects that will not require a biological opinion, i.e. all future actions the Service anticipates are Federal actions. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Cumulative effects analysis as stated here applies to section 7 of the Act and should not be confused with the broader use of this term in the NEPA or other environmental laws.

Operation of the Hogback Irrigation Project results in an average annual depletion of 13,000 af from the San Juan River. This irrigation project was created by the Bureau of Reclamation and operation of the project was subsequently handed over to the Navajo Nation. The irrigation project is interrelated with the Hogback Diversion and Canal because the diversion and canal provide water from the San Juan River that is used in the irrigation project. The Service considered the operation of the Hogback Irrigation Project as an on-going action by the Navajo Nation and because this level of depletion used by the irrigation project is included in the hydrologic baseline for the San Juan River and does not impact Flow Recommendations, this on-going depletion will not have an adverse affect of Colorado pikeminnow, razorback sucker, or their critical habitat.

Conclusions

After reviewing the current status of both fish, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that construction and implementation of the Hogback Fish Barrier, as proposed, is not likely to jeopardize the continued existence of the Colorado pikeminnow and the razorback sucker or result in the adverse modification or destruction of their designated critical habitat.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), take that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such take is in compliance with the terms and conditions of an incidental take statement. Our incidental take statement is specific to a particular life stage and that stage only. For example, the following incidental take statement is specific to larval fish. We make no assumptions about how many adult fish these larval fish may produce and do not predict the number of juvenile or adult fish lost based on the larval number taken.

The measures described below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any grant or permit issued to any applicants, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation (1) fails to assume and implement the terms and conditions, or (2) fails to require applicants to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

The Service anticipates that direct take of larvae will occur during the operation of Hogback Weir during the spawning season. The Service does not anticipate any take of sub-adult or adult individuals due the construction or operation of the Hogback Weir. Because the Service anticipates take of only larval fish and because larval fish cannot be readily quantified using standard monitoring, we used the method described below to estimate the amount of take of larval fishes.

Although there are no known Colorado pikeminnow or razorback sucker spawning sites upstream of the Hogback Diversion Dam, the quality of gravel bars between the Hogback Diversion Dam and the Animas River confluence with the San Juan River indicates that spawning could occur in this area (Bliesner and Lamarra 2003). Both species could potentially spawn as far upstream as RM 180. Assuming potential spawning bars are evenly distributed from RM 128 to180 and RM 100 to180 for Colorado pikeminnow and razorback sucker, respectively; approximately 42% of spawning and therefore larval drift would occur upstream of the Hogback Diversion Dam for Colorado pikeminnow and 28% for razorback sucker. The Hogback Diversion Dam diverts approximately 200 cfs from the San Juan River during both species spawning season. In May, during the razorback sucker peak spawning period, flows on the San Juan River average 4,291 cfs, while in August, during the Colorado pikeminnow spawning peak, flows average 903 cfs. During periods of extreme drought on the San Juan River, flows during both time periods would average 725 cfs. Thus the Hogback Diversion Dam would divert as much as 22% of flow of the San Juan River and as little as 5% during Colorado pikeminnow and razorback sucker peak spawning periods, respectively. Under conditions of extreme drought the Hogback Diversion Dam would divert 28% of the flow of the San Juan River. The proportion of Colorado pikeminnow and razorback sucker larvae that would be expected to enter the Hogback Diversion Dam would be the product of the proportion of spawning occurring upstream of the diversion and the proportion of the flow that would enter the diversion at the time of spawning. Thus, between 9-12% of Colorado pikeminnow and 1-8% of razorback sucker larvae would enter the diversion. Assuming Colorado pikeminnow and razorback sucker larvae are evenly distributed throughout the water column, and because the fish barrier is designed to allow only the upper 5% of the water column to pass over it, less that 1% of either Colorado pikeminnow or razorback sucker larvae spawned above the Hogback Irrigation Canal would become entrained.

Incidental take could occur to larval, juvenile, sub-adult, and adult Colorado pikeminnow and razorback sucker if there is an interruption in the operation of the fish barrier. This take would result in the entrainment of drifting or swimming life stages of the endangered fish in the Hogback Canal downstream of the fish barrier. Operation of the fish barrier could be interrupted by insufficient flow in the San Juan River; mechanical, electrical, or structural failure of the fish barrier; blockage of the fish barrier with ice, vegetation, silt, or trash; and necessary maintenance or modification of the fish barrier to ensure the operation of the fish barrier.

There is some possibility of impingement of sub-adult and adult Colorado pikeminnow and razorback sucker on the trash rack or the fish barrier; however, these structures are designed to have sweeping velocities that would make impingement unlikely. Because sub-adult and adult Colorado pikeminnow are strong swimmers and sub-adult and adult razorback suckers are bottom dwellers, it is unlikely that once fish reach these life stages that they would become entrained in the Hogback Irrigation Canal by passing over the weir wall.

The Service has determined that the anticipated amount of take to larval fish will be insignificant with respect to the continued recovery of endangered Colorado pikeminnow and razorback sucker in the San Juan River for the following rationale.

Effect of Take

The Service determined that project and the associated level of anticipated take is not likely to result in jeopardy to the razorback sucker and Colorado pikeminnow or result in the destruction or adverse modification of their designated critical habitat.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the razorback sucker and Colorado pikeminnow:

1. Reclamation will continue to support and participate in the implementation of the

Program.

2. Through the Program, Reclamation and the BIA shall survey the remaining diversions that exist on the San Juan River for the potential for entrainment and impingement and design appropriate structures to minimize or avoid entrainment and impingement of Colorado pikeminnow and razorback sucker.

3. Prior to any in-water work occurring or the construction of the weir wall, the Hogback Diversion will be cleared of all fish and blocked with seine prior to dewatering. This will prevent any fish from being present in the area where construction of the weir wall will occur.

Terms and Conditions

Compliance with the following terms and conditions must be achieved in order to be exempted from the prohibitions of section 9 of the ESA. The terms and conditions implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. The terms and conditions are non-discretionary.

The following term and condition is established to implement Reasonable and Prudent Measure Number 1:

1.1) Reclamation and the BIA will continue to seek and provide funding, as authorized, for the implementation of the Program.

The following term and condition is established to implement Reasonable and Prudent Measure Number 2:

2.1) To survey the remaining diversions that exist on the San Juan River that have the potential for entrainment and to design appropriate structures to minimize or avoid entrainment, Reclamation and BIA, through the Program, will:

a. Within one year post-survey, Reclamation through the Program will develop a proposed schedule for the design and construction of any fish exclusion systems necessary for any diversions identified on the San Juan River that have the potential to entrainment or impinge Colorado pikeminnow or razorback sucker.

Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's section 7(a)(1) responsibility for these species. In order for the Service to be kept informed of actions that either minimize or avoid adverse effects or that benefit listed species and their habitats; we request notification of the implementation of the conservation recommendations. The Hogback Fish Barrier Cooperative Agreement outlines the responsibilities of the Navajo Nation, Reclamation, Service, and Public Service Company of New Mexico for the operation and maintenance of the Hogback Fish Barrier in order to ensure incidental take of endangered species is minimized.

In order to monitor the sub-adult and adult Colorado pikeminnow and razorback sucker that pass through the Hogback Diversion and are subsequently returned to the San Juan River, a remotely operated PIT tag reader can be installed in conjunction with the construction of the weir wall. Individual fish may pass through the diversion but return to the San Juan River via the sluice channel because they do not pass over the weir wall. Additionally, a remote PIT tag reader can also monitoring the unlikely loss of any sub-adult or adult Colorado pikeminnow or razorback sucker entrained into the Hogback Canal.

Reporting Requirements

Documentation and reporting on the implementation of the conservation measures and terms and conditions will occur within six months after completion of the project and annually thereafter for a period of five years. In the event Reclamation suspects that a species has been taken in violation of Federal, State, or local law, all relevant information should be reported in writing within 24 hours to the Service’s New Mexico Law Enforcement Office (505/883-7814) or the New Mexico Ecological Services Field Office (505/346-2525). The Hogback Fish Barrier Cooperative Agreement includes specific reporting requirements of the Navajo Nation, Reclamation, Service, and Public Service Company of New Mexico.

Reinitation Notice

This concludes formal consultation on the proposed Hogback Fish Barrier on the San Juan River. As required by 50 FR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may impact listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action.

The actions of the Program are expected to result in a positive population response for the Colorado pikeminnow and razorback sucker in the San Juan River. If a positive population response for both species is not realized, as measured by the criteria developed by the Reclamation dated July 6, 2001, this would be considered new information that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion. Therefore, reinitiation of section 7 consultation would be required for all projects dependent on the Recovery Program, including the subject action.

In future communications regarding this project please refer to consultation number 22420-2010-F-0096. If you have any questions or would like to discuss any part of this biological opinion, please contact Scott Durst at 505-761-4739.

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